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ABSTRACT OF DISSERTATION

David R. Barrus

The Graduate School
University of Kentucky

2011

FIRM BIDDING BEHAVIOR IN HIGHWAY PROCUREMENT AUCTIONS:
AN ANALYSIS OF SINGLE-BID CONTRACTS, TACIT COLLUSION, AND THE FINANCIAL IMPACT ON
KENTUCKY

ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Business and Economics
at the University of Kentucky

By
David R. Barrus
Lexington, Kentucky

Director: Dr. Frank Scott, Professor of Economics
Lexington, Kentucky
2011

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ABSTRACT OF DISSERTATION

FIRM BIDDING BEHAVIOR IN HIGHWAY PROCUREMENT AUCTIONS: AN ANALYSIS OF SINGLE-BID CONTRACTS, TACIT COLLUSION, AND THE FINANCIAL IMPACT ON KENTUCKY

Recently, the American Association of State Highway and Transportation Officials (AASHTO) indicated lack of competition and single-bid contracts in asphalt paving as a major issue facing state transportation departments. Single-bid contracts indicate a lack of competition which increases costs to state and local governments. During the period from 2005-2007 in Kentucky, 42 percent of all bids were awarded with only one firm bidding on the project. Of the asphalt paving jobs, 63 percent of those jobs were awarded to a single bidder.

The analysis of this dissertation focuses on detecting tacit collusion in asphalt paving jobs in Kentucky. A focal point enables firms to coordinate bids and engage in a tit-for-tat strategy where they refuse to bid in each other's counties. In this case the focal point is the county boundaries. Two factors contribute to the ability of firms to use county boundaries to coordinate bids. The first factor is that the political county boundaries form relatively small counties which allow a firm's service area to cover multiple counties. The firms are able to claim counties and service the projects in those counties. The second factor is that a majority of asphalt projects which the Kentucky Transportation Cabinet puts up for bidding are exclusive to a specific county. This allows firms to know whether a project falls in a county within their bidding territory.

Each county and firm in each of the 12 Kentucky Transportation Cabinet geographic districts was analyzed to see if there was evidence of bid coordination. The result is that in 94 out of 120 counties there was evidence of bid coordination or tacit collusion with increases in bid levels. There is evidence that 25 of the 31 Kentucky asphalt paving firms refuse to bid against their rivals in their rival's territories. This refusal by firms to bid against each other resulted in single-bid contracts that were \$70,595,466.09 above the competitive level.

KEYWORDS: Tacit collusion, highway procurement auctions, asphalt paving, tit-for-tat bidding strategies, financial impact on Kentucky

David R. Barrus

July 27, 2011

FIRM BIDDING BEHAVIOR IN HIGHWAY PROCUREMENT AUCTIONS:
AN ANALYSIS OF SINGLE-BID CONTRACTS, TACIT COLLUSION, AND THE FINANCIAL IMPACT ON
KENTUCKY

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DISSERTATION

David R. Barrus

The Graduate School
University of Kentucky

2011

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This dissertation is dedicated to my wife, Lindsey.

I love you more than this dissertation.

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1. CHAPTER 1: Introduction to Dissertation

In the 1980s, there was a major push by federal and state governments to weed out and prosecute bid-rigging in highway construction and maintenance auctions, because this overt collusion led to higher costs for government and tax payers. Many firms were convicted of bid rigging which resulted in a decrease in overt collusion during the 1990s. Recently, the American Association of State Highway and Transportation Officials (AASHTO) indicated lack of competition and single-bid contracts in asphalt paving as a major issue facing state transportation departments. Single-bid contracts may indicate a lack of competition which increases costs to state and local governments. During the period from 2005-2007 in Kentucky, 42 percent of all bids were awarded with only one firm bidding on the project. Of the asphalt paving jobs, 63 percent of those jobs were awarded to a single bidder.

Single-bid contracts for asphalt paving jobs in Kentucky for 2005-2007 were 2.22 percent higher than the engineer's cost estimate (see Table 1.1). In asphalt paving, one additional bidder reduces the percent "over or under" the engineer's estimate by 15.75 percent. If the large number of single-bid contracts is a result of tacit collusion and not an efficient equilibrium, then the higher prices result in welfare loss. The question this dissertation seeks to answer is whether the market for asphalt paving and high number of single-bid contracts in Kentucky is a result of an efficient equilibrium and the cost structure of the market, or if there is some other factor behind this such as tacit collusion. In other words, is the bidding behavior of the asphalt paving firms and the high level of single-bid contracts a result of the costs it takes firms to operate and complete projects, or are firms refusing to bid in certain areas and coordinating with other firms with the use of a focal point.¹

There are three main factors that can influence whether or not a firm bids on a project. The first is the cost of submitting a bid. This cost is endogenous to the firm and it can influence whether or not they submit the bid. The second is a random element. This is the fact that a firm

¹A famous example of a focal point is used by Thomas Schelling. When students were asked where and when they would meet a stranger in New York City without communicating with that stranger, the overwhelming response was at Grand Central Station at noon. This example highlights that focal points are usually well known objects (Grand Central Stations) or commonly used meeting times (Noon). Other focal points could be prices or in this case county boundaries. Each firm can observe the existence of a county boundary and can use it to coordinate bids.

may have a slightly lower cost to bid on a particular project due to some random variable. These random variables could be the fact the firm got a good deal on asphalt cement or aggregate, etc. The third part is a strategic factor. A firm may not know how a rival firm is going to bid on a project, and may attempt to coordinate with the rival firm. This strategic element of the bidding process is the factors that can lead to firms overtly or tacitly colluding. The purpose of this strategic behavior could be to raise bid levels so that firms can earn more profit. There has been some work done on analyzing firm strategy and collusive behavior in highway procurement auctions with Feinstein et al. (1985) and Porter and Zona (1993) focusing on detecting illegal overt collusion which occurred during the 1970s and 1980s. Bajari and Ye (2003) is a more recent example of efforts to empirically test for collusion in the seal coat industry in the Midwest.

This dissertation focuses on detecting tacit collusion in asphalt paving jobs in Kentucky. I find no evidence of illegal activity in Kentucky. However, what constitutes illegal behavior can change or shift as political, court, or public opinion evolves. The *Sherman Act* states: "Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States, or with foreign nations, is declared to be illegal."² This has been interpreted by the United States Department of Justice as including "agreements among competitors to fix prices, rig bids, and allocate customers, which are punishable as criminal felonies."³ Generally, some explicit evidence of bid rigging and communication among the firms had to be present in order for the Department of Justice to prosecute bid rigging. At this time tacit collusion is not generally prosecuted simply because, according to Judge Stephen Breyer, "... it is close to impossible to devise a judicially enforceable remedy for 'interdependent' pricing. How does one order a firm to set its prices *without regard* to the likely reactions of its competitors?" (Dennis A. Yao and Susan S. DeSanti, 1993). It is clear that this is not settled law. While tacit collusion is generally not illegal, at some future point political and court opinions may change.

In order to determine if tacit collusion exists, a focal point that enables firms to coordinate bids and engage in a tit-for-tat strategy where they refuse to bid in each other's

² Section 1 of the Sherman Act.; Source: "Sherman Act,"

http://www.law.cornell.edu/uscode/html/uscode15/usc_sec_15_00000001----000-.html.

³ Antitrust Division, Department of Justice <http://www.justice.gov/atr/about/antitrust-laws.html>.

counties is identified. In this case the focal point is the county boundaries. Two factors contribute to the ability for firms to use the county boundaries to coordinate bids. The first factor is that the political county boundaries form relatively small counties where a firm's service area or firm boundary covers multiple counties. The firms are able to claim counties and service the projects in those counties. The second factor is that a majority of asphalt projects which the Kentucky Transportation Cabinet puts up for bidding are excluded to a specific county.⁴ This is similar to how most states let their asphalt projects.⁵ If a resurfacing job crosses a county line, then this project is typically split into two projects for each county. This allows firms to know whether a project falls in a county within their bidding territory. Under equilibrium conditions, distance from the asphalt plant to the project should be the major factor in whether a firm bids on a project. Hot-mix asphalt has approximately 45 to 60 minutes before it must be laid and compacted at the road site.⁶ Thus each firm has a specific service area where they can feasibly bid on projects, which is similar to other asphalt firms in other states.⁷ This prevents firms from coming from long distances and limits the number of competitors to those firms who have the project within their own feasible service area. In some cases there is only one firm that can feasibly service a project, however, 97 percent of projects have more than one firm that can service the project. Tacitly colluding firms may create a situation they can "claim" certain counties as part of their territory. They refuse to bid in counties where a rival firm has an asphalt plant. The rival firms in turn do not bid in their counties. This allows firms to coordinate

⁴ There are 24 jobs that are in multiple counties, however were excluded from this analysis.

⁵ 36 out of the 50 states limit most asphalt projects to one county. Six other states limit some asphalt projects a specific county while other asphalt projects span multiple counties. See appendix for table on all 50 states.

⁶ See Appendix for diagram of asphalt paving

⁷ In general the distribution of asphalt plants in the various states depends on the size of the counties. More urban areas typically have more asphalt plants because there are more jobs. Rural areas typically have less asphalt plants, and there are counties without asphalt plants. In a lot of ways the distribution of asphalt plants in Kentucky is similar to a lot of states in the United States and firms have fixed service areas. For example, in Mississippi, the distribution of asphalt plants is similar to Kentucky. See appendix for a map of asphalt plants in Mississippi. However, some asphalt firms have portable asphalt plants and this greatly expands their service areas. In Montana, firms have portable asphalt plants which make the firms more mobile and able to do projects in different locations throughout the state of Montana. Firms that have portable asphalt plants do not have confined, fixed service areas.

bids without communicating. The result of such tacit collusion may be bid levels that are higher than competitive levels.

In order to test this empirically, I estimate bid functions for 31 asphalt paving firms located in Kentucky who bid on asphalt paving projects let (or put up for bidding) by the Kentucky Transportation Cabinet. I have estimated each of the firms' bid functions in order to understand what factors encourage or deter them from bidding on projects within their service area. Distance from the firm's asphalt plant to the project, the number of contracted projects a firm is working on, the engineer's estimate, the number of potential bidders, and the number of firms that purchased bid proposals are used as control variables in the regression. The focal point used by firms to coordinate bidding, the variable of interest, is a series of county boundary variables. In additional regressions, specific firm and county variables are included in the regression analysis to help understand how firms bid in these situations. What is important in detecting tacit collusion is that both firms are refusing to bid in each other's counties in a tit-for-tat behavior. In other words, "If you don't bid in my county, I won't bid in your county." The presence of this behavior is consistent with tacit collusion between the firms.

The analysis for this dissertation was done on a district basis. Each county and firm in each of the 12 geographic Kentucky Transportation Cabinet districts was analyzed for tacit collusion. The result is that in 94 out of 120 counties there was evidence of tacit collusion which resulted in elevated bid levels (see Table 1.2). There is evidence that 25 of the 31 Kentucky asphalt paving firms refuse to bid against their rivals in their rival's territories. This refusal by firms to bid against each other resulted in single-bid contracts that were \$70,595,466.09 above the competitive level (see Table 1.2). There is evidence that this may be a result of tacit collusion. The results from this analysis are that there is a continuum of competitive situations found in Kentucky. There are counties that are competitive where no evidence of tacit collusion is found. On the other end of the spectrum there are counties such as Pike County where Mountain Enterprises is the only reasonable bidder. In between these two extremes, are counties where evidence of tacit collusion is found, but it has no impact on bid levels. This non-bidding by firms is probably a result of the competitive atmosphere of the county. Jefferson County is an example of where this occurs. There is also a situation where potential competitors refrain from bidding on projects and there is only one bidder on projects in the county and this leads to higher bid levels. Clark County is an example where this occurs.

In order to maintain the collusive arrangements without communicating over months and years there must be a means of enforcing it. Firms can resort to retaliation when a rival firm cheats. One of the most interesting bidding behavior found in this dissertation occurred between Scotty's Contracting and Glass Paving in District 3 and 4. There is evidence of tacit collusion between these two firms. On May 26, 2006, Scotty's Contracting bid on a project in Barren County where Glass Paving had been the primary bidder. This did not trigger retaliation from Glass Paving. However, when Scotty's Contracting bid on a project in Hart County on July 21, 2006 where Glass Paving has one of the asphalt plants and is the exclusive bidder Glass Paving retaliated. At the next bid on August 11, 2006, Glass Paving retaliated and bid on projects in Edmonson, Metcalfe and Monroe Counties where Scotty's Contracting is the primary bidder. The retaliation was immediate and swift. They bid on projects in counties they normally do not bid on. After this retaliation, the bidding went back to "normal" and Scotty's Contracting did not bid in Glass Paving's counties and Glass Paving did not bid in Scotty's Contracting counties through the rest of 2006 and 2007.

The firms that do not engage in tacit collusion are firms such as Kay & Kay Contracting and H&G Construction that have one asphalt plant and bid aggressively against their competitors. Kay & Kay Contracting started bidding regularly on asphalt paving projects in 2006, halfway through the sample. They regularly bid on projects in counties where Elmo Greer & Sons has their asphalt plants. The impact of them bidding regularly has dropped the bid levels significantly. When Elmo Greer & Sons was the lone bidder, the bids averaged 2.81 percent above the engineer's estimate. When Kay & Kay Contracting started bidding regularly it dropped the bid levels to an average of 20.96 percent below the engineer's estimate. The common characteristics of firms that actively bid in and do not engage in tacit collusion is they are usually firms with one asphalt plant and they have a rival firm they target in their bidding. These firms provide competition to the other firms in Kentucky.

These examples highlight how tacit collusion can be maintained and how a competitive firm can drive down bid levels.⁸The primary result of the tacit collusion in Kentucky is a high number

⁸ Another interesting situation is Powell County where Hinkle Contracting and The Walker Company bid on projects. Hinkle Contracting has an asphalt plant in Powell County, but The Walker Company bids on projects in that county. What is remarkable is that even those these firms both bid on projects it does not drive down the bid levels. In fact the multiple bid contracts average higher above the engineer's estimate

of single-bid contracts which occurs in all the districts. The engineer's estimate is used as a benchmark to analyze how much a bid is over or under it. When the percentage over or under the engineer's estimate is calculated for single-bid contracts and multi-bid contracts, single-bid contracts are higher than multi-bid contracts. This is the expected result since competition usually drives down bid levels.

This dissertation is laid out in the following way. In Chapter 2 there is a discussion about overt collusion in the 1970-80s. There is also a discussion of how a project originates and the process it goes through to become reality. There is specific focus on the bidding process and the mechanics of asphalt paving. In Chapter 3 there is an in-depth discussion of the relevant literature which relates to the empirical analysis of collusion and/or highway procurement auctions. There is also a discussion of the difference between overt and tacit collusion, focal points, and tit-for-tat strategies. This sets up the discussion in Chapter 4 about the theoretical framework. This discussion about theoretical framework is followed by a discussion about the origin of the data and how the variables used in the empirical models were constructed. Chapter 5 discusses the empirical models that are used to construct individual firm bid functions. Chapter 6 discusses the results on a district level for all 120 counties and 31 firms. The results discussed in this introduction will be discussed more in depth in the relevant chapters.

than the single-bid contracts. I could find no reasons why this is occurring. However, the behavior does not match what is occurring in the other parts of Kentucky.

Table 1.1: Summary Statistics of all projects in Kentucky – 2005 to 2007

	Number of Projects		Total Value of Projects (\$ in millions)		Over or Under Engineer's Estimate (%)	
Number of Bidders	Asphalt Paving	All Other Projects*	Asphalt Paving	All Other Projects*	Asphalt Paving	All Other Projects*
1	680	154	437.8	737.6	2.22	2.38
2	287	223	121.8	800.8	-13.53	-6.02
3	76	211	36.0	488.3	-16.73	-13.22
4	29	153	11.4	174.4	-15.35	-16.02
5	3	83	1.8	144.0	-14.15	-19.52
6		43		49.8		-17.22
7		23		44.0		-21.30
8		12		17.1		-16.07
9		7		4.6		-26.08
12		1		0.7		-11.05
Grand Total	1075	910	608.8	2,461.1	-3.84	-10.39

*These other projects include grade and drain, bridge, mowing, concrete, etc. Some of these projects have asphalt components as part of the project.

Table 1.2: County break down of competition, collusion, and monopoly

	# of Counties
Competitive	8
Tacit collusion: No increase to bid levels (competitive)	13
Tacit collusion: Increased bid levels	94
Monopoly	5
TOTAL	120

Table 1.3: Tacit collusion in Kentucky and the financial impact by district

DISTRICT	Tacit Collusion	
	# of Counties w/ tacit collusion AND increased	Financial Impact
	bid levels	
DISTRICT 1	4	\$ 928,149.29
DISTRICT 2	9	\$ 8,921,983.04
DISTRICT 3	8	\$ 5,067,574.59
DISTRICT 4	10	\$ 4,980,890.92
DISTRICT 5	5	\$ 884,582.35
DISTRICT 6	7	\$ 845,722.12
DISTRICT 7	12	\$19,378,600.55
DISTRICT 8	10	\$ 9,060,636.59
DISTRICT 9	8	\$ 5,996,119.63
DISTRICT 10	10	\$ 4,974,946.94
DISTRICT 11	8	\$ 8,226,358.58
DISTRICT 12	3	\$ 1,329,901.48
TOTAL	94	\$70,595,466.09

2. CHAPTER 2: Industry Overview

2.1 History of Bid Rigging in the Asphalt Industry

This section provides some background information on the massive bid-rigging investigation over three decades ago. In the 1980s when Ronald Reagan became President of the United States, William Baxter presided over antitrust prosecution and carried out Reagan Administration policy in the United States Justice Department. When President Reagan entered office, he ended the 13-year-old antitrust case against IBM and negotiated the breakup of AT&T. The focus of antitrust prosecution switched from large monopoly cases to prosecution of price fixing and collusion in highway procurement auctions.⁹ The root of the highway bid-rigging investigations can be traced back to Robert H. Collins Sr. who worked for the St. Louis Post-Dispatch. In the late 1950s and early 1960s he started getting tips from sources in Illinois that bid rigging was occurring on highway jobs. He started investigating bidding practices and received a break when a highway contractor told Collins about the collusive bidding practices. His articles were published in the St. Louis Post-Dispatch in the 1970s and led to federal investigations in Illinois.¹⁰ During the investigations in Illinois, a contractor pointed federal investigators to look into highway project bidding behavior in Tennessee. The federal investigation into collusive bidding in Tennessee in 1979 was the beginning of many years of intense federal investigations and prosecutions in at least 29 states during the 1980s.

The pattern of highway bid rigging uncovered in Tennessee was similar in other states. In Tennessee contractors would gather in a Nashville hotel the night before a bid and would determine who would be the winning bidder (low bid). The other contractors would simply over bid with the promise of either being the low bidder another time (rotation of low bidders) or would receive payoffs from the winner to over bid. The major concern for investigators was inflation of bids due to the bid rigging and the extra cost it put on tax payers.¹¹ By 1984 the federal investigation of highway bidding had expanded into 29 states with 181 corporations and 189 individuals pleading guilty, 21 corporations and 25 individuals convicted at trial, while 16

⁹ Rosewicz, Barbara. 1984. "New Antitrust Chief Says He's as Tough as Predecessor," *United Press International*. March 10, 2010,

¹⁰ Press, Robert M. 1982. "Blowing the Whistle on Bid Rigging," *Christian Science Monitor*. March 10, 2010,

¹¹ Sniffen, Michael J. 1982. "Highway Bid-Rigging Investigation Expanded to Five New States," *The Associated Press*. March 10, 2010,

corporations and 22 individuals were acquitted.¹² There were over 600 highway bid-rigging cases during the 1980s.¹³

Highway bid-rigging cases were not the only focus of federal prosecution during the 1980s. Electrical, water, and sewer contractors came under investigation. The investigation into electrical contractor bid-rigging started when William Baxter received an anonymous letter accusing electrical contractors of inflating bids and illegally communicating to determine who would win each contract. Investigations and prosecution began in North Carolina and expanded into at least 15 states.¹⁴

In the mid-1980s, dairy processors who supply milk and ice cream to schools and military bases became the focus of investigators. The Attorney General of Florida applied computer techniques used to detect highway bid-rigging to milk bids and found collusion among firms. It was discovered in Florida that the bid-rigging schemes had been in use since the 1960s. From Florida, state and federal investigations spread into at least 19 additional states. The method of collusion in the milk industry was similar to that in the highway and electrical bid-rigging cases. Firms met and coordinated who would be the low bidder in each school district and for each military base.¹⁵ In Florida it was estimated that overcharges exceeded \$10 million.¹⁶

In 2004, U.S. attorney Diane Lotko-Baker indicated that the intense prosecution of highway bid-rigging in the 1980s led to few cases in the 1990s. In addition, she detailed how the Justice Department had changed methods of investigating price fixing. In the 1980s a grand jury would be organized to gather evidence of the alleged price fixing. Recently, wire tapping became a common practice in order to investigate without alerting parties that they were under

¹² Sniffen, Michael J. 1984. "Federal Highway Bid-Rigging Probe Expands into 29th State," *The Associated Press*. March 10, 2010,

¹³ Ryan, Sean. 2004. "Wisdot Seminar Draws 270," *The Daily Reporter* Milwaukee, WI: March 10, 2010,

¹⁴ Pasztor, Andy. 1985. "Busting a Trust: Electrical Contractors Reel under Charges That They Rigged Bids--- How Anonymous Letter Led to Flurry of Prosecutions; 'Super Conspiracy' Theory --- Code Words and Kickbacks," *The Wall Street Journal*. 1,

¹⁵ Henriques, Diana B. and Dean Baquet. 1993. "Evidence Mounts of Rigged Bidding in Milk Industry," *The New York Times*.

¹⁶ Smith, Diane. 1988. "Lawsuit Charges Major Milk Producers Fixed Prices of Kids' Milk," *The Associated Press*. March 10, 2010,

investigation. It usually begins with an insider coming and telling the authorities of the alleged price fixing. When there is enough evidence obtained through wire tapping then a search warrant is issued. A search of the suspected firm is usually the first time the company is aware they are being investigated.¹⁷

While the lack of prosecution of bid rigging in the 1990s may indicate that highway contractors learned their lesson, there may be a more subtle explanation to the lack of prosecutions. At the end of the Reagan Administration, critics argued there was a lack of focus on larger firms and billion-dollar mergers were seldom challenged. This change or “lack” in focus occurred at the beginning of the Reagan administration as the Department of Justice switched from focusing on big monopoly cases and vertical price-fixing to a focus on the “economic reality” of bid-rigging of small highway construction firms. By the end of Reagan Administration, lawyers and Congress were ready for a more aggressive pursuit of mergers and less focus on bid-rigging.¹⁸

Since the 1980s, overt collusion has not been a major national concern due to a switch of focus from the Department of Justice, the lack of bid rigging due to the heavy prosecution during the 1980s, and better methods, such as wiretaps, to detect bid rigging. However, individual states have seen a decrease in competition. In an August 2005 meeting of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction, the committee identified single-bid contracts and decreasing competition as major concerns. According to a survey commissioned by AASHTO (see AASHTO, 2006), the average number of bidders per project declined from 4.24 in 2002 to 3.36 in 2005, and for Kentucky there was a decline of average bids from 2.94 in 2002 to 2.18 in 2005. The two major reasons cited by departments of transportation for the decline of bids were industry consolidation and increased work with the same number of contractors.¹⁹ In Kentucky this

¹⁷ Ryan, Sean. 2004. "Wisdot Seminar Draws 270," *The Daily Reporter* Milwaukee, WI: March 10, 2010,

¹⁸ Hershey, Robert D. Jr. 1988. "Tougher Antitrust Stance Expected," *The New York Times*. New York, NY: 1, March 10, 2010,

¹⁹ 28 DOTs cited industry consolidation and 27 cited “increased work with same number of contractors” as the major reason. The DOT of Ohio said the following about consolidations: “Not only consolidations but consolidations in a way in which...the little contractor [must] now purchase goods and services from the consolidated contractor that once was their competitor.” Montana has a limited number of contractors with “about 7 contractors receiving 70% of the work.”

trend is not apparent on asphalt paving jobs. Table 2.1 shows the amount of firms per year that were awarded contracts for jobs from 1994 to 2007 and the number of asphalt projects that were contracted out each year. It does not appear during the years from 2005-2007 that industry consolidation was a problem. Also, during 2005-2007 the average number of projects per firm is 10.4 while the average from 1994-2007 is 11.2.

Of particular concern to AASHTO and the Federal Highway Administration (FHWA) are projects with only one bidder, which increased during the time period of 2002-2005. Single-bid contracts are, on average, more prevalent in asphalt resurfacing projects than any other highway construction or maintenance project. According to the survey, Kentucky, Maine, and Mississippi have the highest percentage of single-bid contracts.²⁰ In my discussions with an official in the Kentucky Transportation Cabinet in 2010, single bids are a concern and are primarily located in rural areas. Maine officials indicate that their single bids are spread throughout the state.²¹ In Montana 70 percent of urban projects receive only one bid.²² This lack of competition, particularly in Kentucky, does not come from industry consolidation or increases in projects. These facts motivate this analysis. The question remains if the high level of single-bid contracts is a result of an efficient equilibrium or the result of tacit collusion.

2.2 Highway Procurement Auctions

The high number of single-bid contracts grows out of the method Kentucky uses in distributing bids. The purpose of this section is to explain the process a project goes through from its genesis to its completion to understand the institutional structure that contributes to the tacit collusion. In general, there are many types of projects a State department of

²⁰ The average number of single-bid projects among the surveyed states is 20 percent. According to the survey, 70 percent of all asphalt resurfacing projects in Kentucky have only a single bidder. Data calculated for this analysis indicates that the average proportion of single-bid contracts from 2002-2005 in Kentucky was 62 percent in asphalt paving. It rises to 63 percent from 2005-2007. In 2003, the percent of single-bid contracts is 69. It is around 80 percent for both Maine and Mississippi.

²¹ Officials in Mississippi indicate: "Single bids are not an issue. They have historically occurred in certain areas of the state." Source: AASHTO. 2006. "Aashto / Fhwa Survey on Construction Cost Increases and Competition," <http://www.fhwa.dot.gov/programadmin/contracts/priccomp.cfm>.

²² Officials in Montana indicate: "Montana has more paving contractors and the contractors who are willing to bid on urban jobs are not very mobile. Therefore we typically only get one or two bids for urban jobs and the prices are typically higher than they should be." 30% of all asphalt resurfacing projects in Montana are single bids. Source: *ibid*.

transportation can implement. These projects range from constructing a new road, resurfacing an existing road, trimming trees and mowing grass, maintaining and replacing bridges, etc. Many of the ideas for the projects originate from organized local committees and the general public. These projects are then collected from each committee throughout a State and prioritized by the department of transportation. Projects are selected from this list and put on various transportation improvement lists which, in some cases, are mandated by law. These selected projects have plans drawn up and then funding is sought. Once funding is granted, a project is advertised and then let, or auctioned off, to the lowest bidder. The project is awarded followed by construction and completion.

While this is a vast generalization of how a project comes to be, it highlights the important steps a project goes through to be constructed. The rest of this section will be devoted to understanding the details of this process including planning, design, funding, and bidding. Kentucky will be used as an example; however, the process is very similar in other states.

2.2.1 Planning

The process of bringing a project from idea to construction is generally called *letting program management*. The start of the letting program is the planning phase. There are two parts to the planning phase for each project which includes soliciting project ideas from various organizations and groups and then establishing a long-range transportation plan and a short-range plan.²³

Input on potential projects is gathered from metropolitan planning organizations (MPOs), local government agencies and the general public. A Transportation Improvement Plan (TIP) is federally required and developed by MPOs. Transportation improvement plans developed outside of outside a metropolitan area can be referred to as a rural TIP. These feed into the long-range and short-range plans put together by the various States. The long-range plan is usually 20 years or more and called the Statewide Transportation Plan (STP). Some states have

²³ Anderson, S. D.; Byron C. Blaschke; National Cooperative Highway Research Program.; American Association of State Highway and Transportation Officials. and National Research Council (U.S.). Transportation Research Board. 2004. *Statewide Highway Letting Program Management*. Washington, D.C.: Transportation Research Board.

an intermediate plan that covers a period less than 12 years and the projects in this document either are prioritized or have a specific target letting date. This is the pool of “authorized projects” that a state works with and have been authorized by a State’s legislature and/or department of transportation. A portion of the authorized plan is designated as the Statewide Transportation Improvement Plan (STIP) which must be at least a three-year time horizon. In order to receive federal funds a project must be listed on the STIP. Both the statewide and MPO transportation improvement documents must designate where the funding for the projects is coming from. On the other hand the long-range plan has no monetary constraints but outlines the details and priorities for future projects.²⁴

In Kentucky the long-range plan, Statewide Transportation Plan (STP), deals with a 25-year time horizon. This plan outlines the goals and objectives of the Kentucky Transportation Cabinet and also the current transportation and economic conditions in Kentucky.²⁵ The most recent STP is from 2006, and one of the most important parts of this plan is to identify condition of roads and other modes of transportation and the challenges Kentucky faces. In 2006 the Kentucky highway system consisted of 78,000 miles of public roads and streets with nine interstate highways and nine state parkways. Of this system 35 percent is maintained by the State which equates to 27,500 miles of roads or 60,781 lane miles. At any one time some part of the road system is in need of repairs, widening, rehabilitation or some other form of improvement. It is estimated by KYTC that 33 percent of the interstate highway and 47 percent of parkway pavements needs some sort of repair, and 25 percent of the interstate highway and 29 percent of parkways are rated in “poor” condition. Deteriorating roads can lead to increased delays, more traffic accidents and fatalities, and increased costs to vehicle drivers. The conditions of the roads have been deteriorating since the late 1990s which is due to increases in truck traffic and decreases in funding for maintenance and rehabilitation due to “eroding buying power of the transportation dollar” and the recent economic recession.²⁶

²⁴ Ibid.

²⁵ The three major goals of the Statewide Transportation Plan include (1) safety and security, (2) system preservation, and (3) economic opportunity and mobility. Source: Kentucky Transportation Cabinet. 2006b. "Kentucky Long-Range Statewide Transportation Plan," Division of Planning, Frankfort: Kentucky Transportation Cabinet, 66, <http://transportation.ky.gov/planning/stp/2006stp.asp>.

²⁶ Ibid.

The Transportation Cabinet's Six-Year Plan (SYP), also referred to as the Recommended Highway Plan, is a collection of projects which are compiled and updated by the Transportation Cabinet every two years and submitted to the Kentucky General Assembly for approval. Once the Six-Year Plan is approved by the General Assembly the Transportation Cabinet assembles the Statewide Transportation Improvement Plan (STIP) from the six-year plan. The STIP covers a period of four years and is required in order for Kentucky to get federal funds. The projects in the STIP have gone through "an extensive identification process" which includes public feedback. The SYP and STIP do not specifically include every project the Transportation Cabinet does in a given year.²⁷

Projects specified in the STIP are major projects like bridge replacement, major widening of a road, etc. An example of one of these projects in the 2005-2007 STIP is a project in Scott County where U.S. 62 would be widened from I-64 to the Georgetown Bypass during the 2005 fiscal year, and \$9,000,000 was allocated for the project. Not all projects are specifically designated such as this project. The category "Z-Various" is money "for projects that are determined on an annual basis for various types of work." Money is allocated in this category in the STIP to a particular type of work and not to a specific project. For example, \$10,000,000 was allocated for the 2005 fiscal year for "statewide primary pavement rehabilitation." In this way funds will be available for the more minor projects such as smaller asphalt resurfacing jobs.²⁸

The projects on the Six-Year Plan are authorized for different parts of the development and construction. A project is designated in four categories in the short-range plans: design, right of way acquisition, utility relocation, and construction. Funds are allocated to these different stages of project development. For example, in the FY 2005-2007 STIP a bridge replacement project in Harlan County on state route KY 219 is specified for each stage. The design phase is to be during the 2005 fiscal year and \$100,000 was allocated for this portion of the project. During 2006 right-of-ways were to be obtained and utilities were to be relocated with \$400,000 and \$75,000 allocated for each job respectively. The remaining funds for the project of \$525,000 are

²⁷ Kentucky Transportation Cabinet. 2007. "Interested Parties, Public Involvement & Consultation Process," Division of Program Management, Frankfort: Kentucky Transportation Cabinet, August 16, 2010, <http://transportation.ky.gov/progmgmt/>.

²⁸ Kentucky Transportation Cabinet. 2004. "Statewide Transportation Improvement Plan for Fy 2005-2007," Division of Program Management, Frankfort: Kentucky Transportation Cabinet, August 16, 2010, <http://transportation.ky.gov/progmgmt/stip/stip1.htm>.

for the actual construction of the bridge during 2007. In this way projects are planned out and funds are designated for specific years. This spreads the cost of constructing a road or bridge over many years. Not all projects have these different stages of development. For example, a resurfacing job of an existing road would not need to go through a phase to obtain right-of-ways or relocate utilities. In other words, every project is unique and the different stage of development each project goes through is unique.²⁹

The environmental studies, feasibility studies, and developing a right-of-way plan are done to determine the viability of the project. At least a portion of this is done before a project is authorized to be constructed. Once a project has been authorized to be completed then advance work is done on plans, specifications and estimates. When a project falls within about one year of the targeted letting date it is moved to a bidding schedule. Each project is evaluated to determine which projects line up with the current funding available. When funding is identified the projects are prepared to be let or bid upon. Some departments of transportation have project plans and estimates already completed and when funding becomes available those projects are fast tracked.³⁰

The projects of interest in this analysis are asphalt paving projects, and these projects can originate from one of two paths before they are let for construction. The first path of origination is for the project to go through the full planning process, be attached to a Six-Year Plan (SYP) and State Transportation Improvement Plan (STIP) and be approved by the Kentucky General Assembly. These projects typically include major roadway rehabilitation, new road construction, major widening, or other major improvement. The second set of projects are non-Six-Year Plan projects which include resurfacing projects, maintenance, highway operations, general administration, etc.³¹

²⁹ Ibid.

³⁰ Anderson, S. D.; Byron C. Blaschke; National Cooperative Highway Research Program.; American Association of State Highway and Transportation Officials. and National Research Council (U.S.). Transportation Research Board. 2004. *Statewide Highway Letting Program Management*. Washington, D.C.: Transportation Research Board.

³¹ Source: Kentucky Transportation Cabinet. 2010a. "2010 Recommended Highway Plan," K. T. Cabinet, Frankfort: Kentucky Transportation Cabinet, <http://transportation.ky.gov/highways/>.

2.2.2 Design

In Kentucky, once a project is on the Six-Year plan it enters the design stage. The design stage consists of plans being drawn up along with project specifications, environmental clearances granted, and costs estimated. The Office of Project Development is over the design process and getting the plans ready for the bidding process.³² Some projects have certain deadlines when the design and right-of-way acquisitions must take place but other projects do not have these time constraints. However all projects have a deadline when construction is going to begin. Most projects are the responsibility of the Chief District Engineer who appoints a project manager and project development team. However there are certain cases where project design is done in the Rehabilitation & Pavement Branch of the Division of Highway Design.³³ In order to get project authorization, a Project Scoping Summary and cost estimates of each phase of development must be completed.³⁴ Once authorization is granted then work can proceed on the project.³⁵

The first part of design is to obtain environmental approval and select an alternative to the project. This is the conceptual design phase and numerous meetings are held within the project team and with the public to determine the impacts and alternatives to the project. After the studies are completed and it is determined that there will be no significant impact on the

³² The Office of Project Development includes the Division of Highway Design, Division of Structural Design, Division of Environmental Analysis, and Division of Right-of-Way & Utilities. The Deputy State Highway Engineer is responsible for the design process.

³³ The criteria for whether a project is designed by a district project team or a team in the Rehabilitation and Pavement Branch depends on the scope and scale of the project. If the project is a National Highway System road, a road that gets a high volume of trucks and traffic it is usually designed by the Rehabilitation Pavement Branch. The National Highway system consists of roads such as Interstates and Strategic Highway Network (STRAHNET) roads "which are important to the United States strategic defense policy and which provide defense access, continuity and emergency for defense purposes." They also include roads that connect major highways and military installations. The other projects are designed by the district design teams. Sources: Kentucky Transportation Cabinet. 2006a. *Highway Design Guidance Manual*. Frankfort, Kentucky: Kentucky Transportation Cabinet., Federal Highway Administration. 2010. "The National Highway System," FHWA, <http://www.fhwa.dot.gov/planning/nhs/>.

³⁴ The Project Scoping Summary is prepared on every Six-Year Plan project one year before project design is authorized and includes a project description, road characteristics, potential alternatives, design criteria, cost estimates, etc. Source: Kentucky Transportation Cabinet. 2006a. *Highway Design Guidance Manual*. Frankfort, Kentucky: Kentucky Transportation Cabinet.

³⁵ Ibid.

environment and an alternative is selected, the project moves on to the final design phase. In the final design phase the project team finishes the detailed plans for right-of-way acquisition, utility relocation, and construction.

An important part of the final design phase is estimating the cost of the project and building in incentives or disincentives for contractors. Some innovative methods that could be used in design a plan to ensure on-time completion includes “cost plus time” bidding, lane renting, and other incentives and/or disincentives. The concept of “cost plus time” bidding takes into account the traditional costs of construction (“cost”) and also the cost to drivers during the period of construction (“time”). The “time” cost is determined by multiplying the length of time the project will take to complete by the “road user cost per day” which is established by the project development team. This is then the total cost estimate for the project. Other incentives include payouts to contractors who finish on-time and by charging the contractor extra if the project goes over in days. Also some projects require the contractor to “rent” lanes during the duration of the project. This is an extra fee charged to a contractor to close and use the lane during construction. This is a fee on top of the bid.³⁶

Once the plans are complete, they are submitted to various areas within the Kentucky Transportation Cabinet and reviewed. The plans must be submitted to the Plan Processing Section and must include the cost estimate and estimated completion date. The plans are reviewed to determine “constructability” and to make sure everything is in order. After all the reviews are complete the project manager submits the contract plans to the Plan Processing section 60-90 days before bidding. These plans are sent to the district office where the project will be completed and are put on public display before bidding occurs.³⁷

2.2.3 Funding

In 2006, Kentucky spent \$1.7-1.8 billion on transportation related projects. Sixty-three percent of money spent on transportation projects came from the State Road Fund which consists of money obtained through taxes and fees levied on motor vehicle usage, motor fuel, vehicle and boat registration, operator’s licenses, and tolls. These funds are used to fund road construction, maintenance, engineering, planning, research, operations and the administration

³⁶ Ibid.

³⁷ Ibid.

of the Kentucky Transportation Cabinet. The other significant part of the transportation budget was supplied by federal allocations (30.7 percent) through the Federal Highway Trust fund, public transit, FAA, and other grants and earmarks.³⁸ These funds are also used in various transportation projects which are and must be included in the Statewide Transportation Improvement Plan (STIP). The other funds come from the general fund and restricted state funds.³⁹ One of the major problems for Kentucky is that growth rate of transportation funds from year-to-year (as of 2006) was only growing at 0.66 percent per year-well below the annual inflation rate which was 3.2 percent in 2006.⁴⁰

The annual state road funds are split three ways. Part of the funds goes into the non-six-year costs which include resurfacing projects, maintenance, highway operations, general administration, etc. The second part of the funds directly goes into the SYP recommended projects for the year. The third part of the funds goes to match funding for federal projects which are then funneled into the highway plan. The Secretary of Transportation and KYTC's Authorization Review Team reviews the funding available to determine which projects can be funded for the coming period.⁴¹ The first question this review team asks in the monthly meeting is whether or not a state project is far along in the development process, and the second question is whether or not there are available funds.⁴² One of the issues under discussion in this dissertation is the use of county boundaries and focal points for tacit collusion. If a project crosses a boundary such as a county line then funding separators might be required. In some

³⁸ Source: Kentucky Transportation Cabinet. 2006b. "Kentucky Long-Range Statewide Transportation Plan," Division of Planning, Frankfort: Kentucky Transportation Cabinet, 66, <http://transportation.ky.gov/planning/stp/2006stp.asp>.

³⁹ The State general funds (0.3 percent) come from the collection on sales, income, corporate, and property taxes along with lottery receipts. These funds are used to match federal dollars for public transit and aviation programs. The restricted state fund (6.0 percent) money are collected from fees, sales, bond proceeds, licenses, investment income, and other receipts, and is only used for the respective project the revenue was collected for. Source: *ibid*.

⁴⁰ This inflation rate is the Consumer Price Index – All Urban Consumers and is the annual rate for 2006. Source: Bureau of Labor Statistics. 2006. "Consumer Price Index - All Urban Consumers," data.bls.gov.

⁴¹ The Authorization Review Team consists of Transportation Cabinet Chief of Staff, the State Highway Engineer, and the KYTC Budget Director. Source: Kentucky Transportation Cabinet. 2010a. "2010 Recommended Highway Plan," K. T. Cabinet, Frankfort: Kentucky Transportation Cabinet, <http://transportation.ky.gov/highways/>.

⁴² *Ibid*.

cases when certain funds are used it is required to separate funds by county.⁴³ On roadway projects funding is separated by county. Therefore, KYTC usually separates projects by county. This enables firms to know which projects will be in which county. This is a good illustration of how the process promotes projects being exclusively in a county.⁴⁴

2.2.4 Bidding

The next phase of the process is the bidding or letting of the projects. There are several factors that determine if a project is placed on a letting schedule. The project needs to have the plans and design completed, funding available, environmental clearances received, utility adjustment and any right-of-way needs to have been acquired. In general, the letting schedule consists of each projects location, group responsible for the project, a brief description of the project, the target bid date, and the estimated cost range. In general, projects are let weekly, bi-weekly, monthly, or on some other schedule. The frequency of when projects are let vary from State to State. In Kentucky, projects are let on a monthly schedule. However, there are some common factors that each State does. For example, each project is advertised for a certain period of time, bid proposals and plans are available for purchase and then bids are submitted. Most states require that contractors working for them must be prequalified and require that bid proposal and/or project plans must be purchased.⁴⁵ To bid on a highway construction or maintenance project in Kentucky, all firms must be pre-qualified by the transportation cabinet and the list of pre-qualified firms is publicly available. Care is taken by the transportation cabinet that the contractor does not take on too much work, and an independent firm analyzes the

⁴³ A KYTC transportation official stated that for certain types of projects designated “rural secondary” the money must go to the specific counties. For other funding sources they can be mixed county. However, counties are usually only mixed together in one project if it is beneficial.

⁴⁴ The exact wording from the design manual is as follows: “When a roadway project crosses boundaries, such as county or rural-urban, funding separations may also be required. Federal project funds are separated by county or by rural-urban boundaries, with different federal project numbers when two or more are required, and by participating and nonparticipating quantities when applicable. A roadway project crossing county boundaries requires separation of state project funds only. Tie all boundary lines to the project centerline by station and bearing. Separate and summarize quantities for each section.” Source: Kentucky Transportation Cabinet. 2006a. *Highway Design Guidance Manual*. Frankfort, Kentucky: Kentucky Transportation Cabinet.

⁴⁵ Anderson, S. D.; Byron C. Blaschke; National Cooperative Highway Research Program.; American Association of State Highway and Transportation Officials. and National Research Council (U.S.). Transportation Research Board. 2004. *Statewide Highway Letting Program Management*. Washington, D.C.: Transportation Research Board.

contractor's finances. Officials hold meetings with all potential contractors on projects during the next year to determine the letting schedule. Projects are moved around on the schedule in order to accommodate potential contractors. Firms are prequalified for certain work and if they are not qualified they cannot do the work. For example, there are two levels of projects that an asphalt firm can be qualified for.⁴⁶

Once the Division of Construction Procurement has received the approved plans, the project is advertised. The project must be advertised between 7 to 21 days before the project is to be let. The advertisements consist of notices in the leading newspaper in the county the project is in, and a Notice to Contractors is mailed out and posted on the KYTC website. The firms must purchase a bid proposal in order to be eligible to bid on a project. The bid proposal costs \$10 and the names of those firms who purchase the bid proposals are publically available the Friday before the bids are opened.⁴⁷ Before 2008, a firm could ask to have their company name not included on the publically available bid proposal list.⁴⁸

Bids are opened on the designated day and the lowest bidder on a project is revealed. This does not necessarily mean the project will automatically be awarded to the lowest bidder, but the transportation department analyzes the bid to see if it a legitimate bid. Most low bidders are awarded the project. There are various reasons a contractor who submits the lowest bid may not be awarded the project, ranging from incomplete paper work to evidence of collusion. Some States use the American Association of State Highway and Transportation Officials (AASHTO) Trns•port System which is a program that is used to detect collusion. It can compare the bids to the engineer's estimate, the other contractors who bid, and also create reports on past bidding behavior, market prices, price differences according to various parameters such as geography. In

⁴⁶ Kentucky Transportation Cabinet. 2005. "Contract Procurement," Division of Contract Procurement, Frankfort: Kentucky Transportation Cabinet,, August 19, 2010, <http://transportation.ky.gov/kytci-forms/PolicyManuals.htm>.

⁴⁷ A contractor can purchase a bid proposal up until 3:00 pm the day before the bid opening. Source: *ibid*.

⁴⁸ After 2008, a company was no longer allowed to have their company name removed from the bid proposals. The purchasing of bid proposals was replaced in 2010 by a bidder registration form. A firm still must fill out the form for the projects they are going to bid on. It is still due at 3:00 pm the day before bids are opened. The list of eligible bidders is still published before the bids. Source: Construction Procurement, Kentucky Transportation Cabinet <http://transportation.ky.gov/contract>.

order to detect collusion some States only have the contractors sign a statement or affidavit which states they have not engaged in collusive behavior in preparing their bid.⁴⁹

In Kentucky, sealed bids are opened and read aloud once a month at a meeting at the Kentucky Transportation Cabinet building in Frankfort, Kentucky. The bid is checked to ensure that all proper forms are signed and that a bid bond or guaranty of 5 percent of the total bid is valid and with the bid. Bids are checked to see if a unit price for any pay item was omitted and to make sure the unit price is for the entire quantity that will be used for the project. The Kentucky Transportation Cabinet then analyzes the bids for 10 days before awarding a contract. The bids are analyzed to see if the bid is unbalanced, front-loaded or if there is any indication of collusion.

First, the transportation cabinet looks at the overall total of the bids and compares them to the engineers' estimate. In some states the engineers' estimate is available before the day of bidding, while in other states, like Kentucky, it is not available before the bid. An unwritten rule in Kentucky is that if bid is 7 percent over the engineer's estimate it should be rejected.⁵⁰ However, this rule is seldom followed.⁵¹ Individual elements of the bid are analyzed to see if the bid is unbalanced or front-loaded. According to the Federal Highway Administration, a bid is unbalanced if it has bid elements that are deemed to be too high or inflated while other elements are reasonable. A key component in determining if a bid is unbalanced is if the government believes that the inflated component(s) could be provided at a lower cost. This is a judgment call on the part of the transportation department. If a firm front-loads a bid then the firm would receive an "unreasonable" amount of money at the beginning of the project.⁵² Once again the determination of "unreasonable" is left to the transportation department. As

⁴⁹ Anderson, S. D.; Byron C. Blaschke; National Cooperative Highway Research Program.; American Association of State Highway and Transportation Officials. and National Research Council (U.S.). Transportation Research Board. 2004. *Statewide Highway Letting Program Management*. Washington, D.C.: Transportation Research Board.

⁵⁰ Some states do have an engineer's estimate. In some cases, such as Texas, the engineer's estimate is publically available before the bid. In other states, like Kentucky, the engineer's estimate is not available until after the bid is over. In Hawaii, they present a bid range where the project should fall in. While still in other states, I found no evidence that the state had an engineer's estimate.

⁵¹ Griffith, Ryan. 2010. "Personal Interview," Frankfort, KY:

⁵² Federal Highway Administration. 1988. "Memorandum: Bid Analysis and Unbalanced Bids," FHWA, August 19, 2010, <http://www.fhwa.dot.gov/programadmin/contracts/051688.cfm>.

mentioned earlier, the bids are also run through computer software to see if there is any indication of collusion. After all this analysis, if the lowest bid is judged to be “reasonable” then the firm is awarded a contract. The transportation cabinet can reject the bid if the bids are deemed “unreasonable” or there is some other irregularity. Projects with only one bid that are deemed to be “reasonable” are not rejected.⁵³ The Awards Committee makes sure there is enough funding and obtains the necessary approvals before notifying the winner. The winning bidder signs the contract and documentation of payment, insurance, and earning schedule for employees are provided to the transportation department.⁵⁴

2.3 Asphalt Paving

The projects in this dissertation focus solely on asphalt paving without any other components such as grade and drain, bridge work, mowing, etc. The asphalt paving process will be detailed in this section. The important part of the asphalt paving process is the time constraint which limits how far away from a plant a particular firm can bid. This time-constrained area is a firm’s feasible service area. Projects that are on the out edge of the service area raise costs to the firm. As the trucks travel farther from an asphalt plant, the increased distance raises transportation costs because asphalt is heavy and hence costly to transport. Firms also could service two nearby projects in the time it takes to complete one project in a neighboring county that is quite a distance from their asphalt plants. These key components along with other components of this process are important in the analysis for tacit collusion and these aspects will be highlighted throughout.

Once a contract is signed between Kentucky and an asphalt paving firm the process of paving a stretch of road begins. The appendix contains a graphic description of the paving process. The process of paving a road begins with the extraction of rock (aggregate) from a quarry and the distillation of asphalt cement or bitumen from crude oil. The cost of paving a road varies as the price of the aggregate and the asphalt cement varies. These two important components are combined at high temperatures at an asphalt plant. The resulting hot-mix asphalt (HMA) is dispensed into trucks and driven to the project site. Care has to be taken to not

⁵³ Griffith, Ryan. 2010. "Personal Interview," Frankfort, KY:

⁵⁴ Kentucky Transportation Cabinet. 2005. "Contract Procurement," Division of Contract Procurement, Frankfort: Kentucky Transportation Cabinet,, August 19, 2010, <http://transportation.ky.gov/kytci-forms/PolicyManuals.htm>.

let the mixture cool too much before compaction. The distance that a truck can reasonably travel before the hot-mix asphalt cools to untenable levels determines a firm's service area. The calculation of this service area is important in the analysis of tacit collusion. The method of identifying these service areas will be detailed later on in Chapter 3. Once the hot-mix asphalt reaches the project site the truck dumps the hot-mix asphalt into a paver which levels and spreads the mixture evenly. A roller follows behind to compact the mixture before it cools. An asphalt road usually consists of a base layer with an intermediate and surface layer made from asphalt. The following sections detail this process along with the economic issues associated with asphalt paving. Specifically, the costs associated with asphalt production will be detailed since they are important to whether or not a firm bids on a project. The first section will detail the process of obtaining aggregate and asphalt cement followed by discussion of designing hot-mix asphalt mixtures and detailed information how an asphalt plant works. The last section will deal with laying and compaction of hot-mix asphalt.

2.3.1 Aggregate

Rock or aggregate is the main ingredient in hot-mix asphalt. It is extracted from quarries and makes up over 90 percent of the total weight and 75 percent of the total volume of hot-mix asphalt. It is also one of the costs of producing hot-mix asphalt. Asphalt plants are typically located near or in quarries where the sand, gravel, and crushed stone are extracted. Asphalt firms may be vertically integrated and actually own the quarry or they may contract out to another firm to obtain the aggregate. Firms located near quarries have a cost advantage since transportation of the gravel and sand from the quarry to the plant are minimal. This can create cost advantages for firms who have strategic agreements with quarries, are located near a quarry, or own a quarry. If asphalt plants and quarries have strategic agreements of exclusivity it could potentially be a barrier to entry of competition. Besides the high start-up costs (around \$1 million) the new firm may not have ready access to aggregate.⁵⁵

Generally, the most commonly used aggregates are sand, gravel, crushed stone, slag, and rock dust. Aggregate creates the structure for asphalt pavements while the asphalt cement

⁵⁵ Humrickhouse, Scott and Carol. Edwards. 1997. "Hot-Mix Asphalt Producers Monitor Profitability through Benchmarking," *Roads & Bridges*. Arlington Heights Illinois: Scranton Gillette Communications Inc.,

binds the aggregate particles together. In choosing an aggregate for a road project size, texture, composition and surface area of the aggregate must be taken into account. The size of the aggregate is important in the designing the mix of hot-mix asphalt. Usually the range and percentage of certain sizes of rock in a mix is what is important.⁵⁶ For example of load of aggregate from a quarry may contain 50 percent of rock that is 0.75 inches in size and 35 percent of rock that is 0.5 inches with the remaining being smaller particles and mineral filler. Other characteristics that make aggregate acceptable to use in the construction of roads is “cleanliness” or the lack of certain material such as vegetation, shale, soft particles, and lumps of clay. The aggregate must also be able to be tough enough to hold together under the wear and tear of extraction, sizing, mixing, and compaction. The particle shape is important. The particles are shaped to be angular so when the hot-mix asphalt cools the aggregate will interlock to strengthen the road. The aggregate also cannot be porous, but must be able to absorb some of the asphalt cement when it is mixed in. One of the more important characteristics is that the aggregate has to be resistant to “striping” which happens when the asphalt cement does not bind with the rock. The types of rock that are suitable for aggregate are limestone, dolomite, and traprock. The aggregate is hauled from the quarry to the asphalt plant where it is stored in piles according to size.⁵⁷

2.3.2 Asphalt Cement

The other important ingredient in hot-mix asphalt is asphalt cement, which is typically used to bind aggregate together. Asphalt cement (bitumen) is a byproduct of the refining process of crude oil and the price of asphalt cement fluctuates according to the price of oil. One of the residuals left after the refining process is liquid asphalt cement which is a hydrocarbon mixture.⁵⁸ The temperature at which asphalt cement is distilled from crude oil is around 500°C (~900°F). It is what is left over after all other products have been extracted from the oil. The advantage of asphalt is that as the temperature changes the consistency of the asphalt cement

⁵⁶ This is referred to as the gradation of the aggregate. Hot-mix asphalt is graded by the percentage of different-size aggregate particles it contains. Source: Asphalt Institute. 2000. *Construction of Hot Mix Asphalt Pavements*. Lexington, KY: Asphalt Institute. P. 2-32.

⁵⁷ Ibid.

, ibid.

⁵⁸ PAIKY. 2010. "Where Liquid Asphalt Comes From," A short description of the process used to get liquid asphalt from crude oil., www.paiky.org.

will change. At high temperatures it is very fluid and a liquid. However, as it cools it begins to solidify and harden. This allows the asphalt cement to be sprayed on the aggregate at high temperatures; however it must be laid and compacted before the temperature of the mixtures falls below 85°C (185°F). Below this temperature the asphalt starts to crack and will not set properly. (Asphalt Institute., 2000)

In terms of volume, hot-mix asphalt consists of 75% aggregate, 17% asphalt cement, and 8% air voids. The air voids are important in allowing the mixture to expand as the temperature increases and also let the asphalt to slightly compact under the weight of traffic. It is essential that the proportions of aggregate, asphalt, and air voids are correct to allow the asphalt pavement meet the project specifications.⁵⁹ In order to obtain proper mixtures of hot-mix asphalt and to accomplish the objectives of the project, there are three mix-design methods typically used: Marshall Method, Hveem method, and Superpave® (Superior Performing Asphalt Pavement). These methods are all used to determine “the optimum asphalt content for a blend of aggregate.”⁶⁰ The Superpave method is used to design asphalt mixtures that will be able to handle high traffic loads and extreme temperature fluctuations. This method can be used for interstates and other roads that are similar. The decision on the design of the mixture usually rests with the State which is contracting the project out (Asphalt Institute., 2000). The most common mixture is dense-graded which is designed, when compacted, to not allow water or other materials through and provide a smooth driving surface. (AASHTO et al., 2000)

The layers of a road include the subgrade which is graded and compacted soil that the road will sit on. Next, is the base which is usually a layer of aggregate. This layer is typically sprayed with liquid asphalt to hold the aggregate together and weatherize the base, but it must be swept clean of all dust and particles before the asphalt layer can be laid.⁶¹ On top of the base layer is an intermediate layer which is either existing asphalt, a new layer of asphalt, or Portland

⁵⁹ Some of the other objectives in designing a hot-mix asphalt mixture is to test to see if the mixture, when set, is durable, stable, impermeable, workable, flexible, fatigue resistant, and skid resistant.

⁶⁰ The Marshall and Hveem method usually focus on mixtures with aggregates under 25 mm (1 in.) or less. The tests for the Marshall method are a density-void analysis and a stability-flow test. The Hveem method employs a CKE test, stability, test, and swell test. Source: Asphalt Institute. 2000. *Construction of Hot Mix Asphalt Pavements*. Lexington, KY: Asphalt Institute. pp. 3-12 to 3-30.

⁶¹ The prime coat sprayed on the base layer is either medium curing cutback asphalt or emulsified asphalt prime (EAP).

Cement Concrete (PCC). (Asphalt Institute., 2000). A tack coat is sprayed on this layer to bond the intermediate layer with the surface layer.⁶²

The surface layer of the hot-mix asphalt mixture Conventional dense-graded hot-mix asphalt is the most commonly used hot-mix asphalt for roads in the United States and has aggregate particles ranging from 12.5-19 mm (0.5-0.75 in.).⁶³ Other types of asphalt mixtures are open-graded and gap-graded. The open-graded mixture serves as drainage layer either on the surface or in a sub-layer of the roadway. Whether this mixture is on the top of the roadway or in a sub-layer its purpose is to drain water. This drainage prevents tire noise and hydroplaning on the surface and water damage on the lower layers. These types of asphalt mixtures can make roads quieter and safer for motorists in wet conditions. The third type of mixture is gap-graded. Of particular interest is stone-matrix asphalt which is basically aggregate with not as much asphalt cement. The open-graded and gap-graded techniques are newer and are used to make roads that last longer and are a better ride for motorists.⁶⁴ No matter what the project is, an asphalt firm has to be able to carry out the design and specifications of each asphalt project.

Once the right design mixture has been determined for the project, the aggregate and asphalt cement need to be combined in an asphalt plant. This process is sensitive to temperature and from the initial combining of aggregate with asphalt cement to the time the hot-mix asphalt is laid is limited. There are two basic types of asphalt plants and the costs and operations of the plants will be described in the next section.

2.3.3 *Asphalt Plants*

The start-up costs of a new asphalt plant are around \$1 million, according to Kentucky transportation officials. In addition to these start-up costs, other operating costs include the aggregate, asphalt cement, fuel to run the asphalt plant, and labor. Analysis from 1997 indicated

⁶² The tack coat is diluted emulsified asphalt. See Appendix for a diagram of the different layers of an asphalt road.

⁶³ Aggregate size for dense graded mixture ranges from 12.5-19 mm (0.5-0.75 in.) for the conventional mixture, 25-37.5 mm (1-15.in.), for the large-stone mixture, and less than 9.5mm (0.375 in.) for sand asphalt. Source: AASHTO; National Research Council (U.S.). Transportation Research Board.; United States. Army. Corps of Engineers. and United States. Federal Aviation Administration. 2000. *Hot-Mix Asphalt Paving Handbook 2000*. Washington, D.C.: US Army Corps of Engineers.

⁶⁴ Ibid.

that 59 percent of all asphalt plants in the United States were 21 years old or older. Only 15 percent of asphalt plants have been around less than 5 years.⁶⁵ However according to Kentucky transportation officials only three new firms have tried to enter the market in the last 10 years and not all of them have survived. Firms that have been in the market for long periods of time can benefit from economies of scale.

In doing a rough analysis of the firms who bid on asphalt projects from January to April in 2005 the results indicate that for every additional 1,000 tons of asphalt a firm produces it decreases the per unit price in a range from around \$0.50 to about \$1.00.⁶⁶ This translates into a range of \$0.0005 to \$0.001 decline in price for every additional ton of asphalt produced.⁶⁷ While this does not directly translate into costs for the firm, it is telling that as more is produced the per unit price declines. Probably one of the major things causing this decline is declining average costs. This example illustrates economies of scale in the asphalt industry. One thing that is occurring is that the high fixed costs of start-up can be spread over the tons of hot-mix asphalt produced since the firm started. This is a disadvantage and a barrier to entry to outside firms trying to enter the market. This leads to relatively stable market with the same firms being around over a long period of time. A few things help asphalt plants achieve economies of scale. Of the 31 asphalt firms, 9 of those firms own their own crushed stone or sand and gravel quarry (see Appendix for complete list of approved quarries). This includes Rogers Group and Scotty's Contracting that own six quarries, Gaddie-Shamrock and Nally & Haydon that own two quarries, and The Allen Company, Glass Paving, Lexington Quarry, Nally & Gibson Georgetown, and Yager

⁶⁵ Humrickhouse, Scott and Carol. Edwards. 1997. "Hot-Mix Asphalt Producers Monitor Profitability through Benchmarking," *Roads & Bridges*. Arlington Heights Illinois: Scranton Gillette Communications Inc.,

⁶⁶ In order to do this rough analysis, projects were identified by asphalt type. The bids contain how much asphalt was used for the project and the unit cost for the asphalt. The unit cost is also the average cost for the asphalt. These average costs were plotted and a trend line was fitted to the data. The slope of this line was downward sloping which meant as more asphalt was produced, the average cost of producing it declined. The numbers in the text are a rough estimate with confidence intervals factored in. The slope of the trend line was -0.0007.

⁶⁷ This number is a very rough estimate and includes 20 of the 31 firms represented in this dissertation. This number is given only as evidence of economies of scale in the asphalt paving industry. The unit price for a ton of asphalt averages around \$40.

Materials that own one quarry.⁶⁸ This can reduce the costs of paving to these firms. Also, larger firms with multiple asphalt plants can buy aggregate, asphalt cement, and fuel in bulk ensuring a lower cost to produce the asphalt.⁶⁹ This presents a unique opportunity for asphalt firms. The more these firms can lower costs and keep competition from entering the market the more profit they can gain especially through higher bids.

Profit margins are even larger when firms engage in bid coordination through collusive behavior. While this occurred in the 1980s overtly, the market is relatively stable and many companies have been around for a long period of time competing against each other. The economies of scale, high barriers of entry, and familiarity among competitors create a situation and an incentive for firms to further increase their profit margins by coordinating bids tacitly. In the analysis of this dissertation, some firms utilize county boundaries to tacitly collude.

To better understand the costs associated with producing asphalt the following paragraphs detail the workings of two commonly used hot-mix asphalt plant types: batch and drum-mix. In Kentucky firms have either of these two types of plants. The main difference between the plants is the process of combining the heated asphalt cement with the aggregate.

Batch Plants

Batch plants produce one batch of hot-mix asphalt at a time and where these types of plants get their name. The aggregate is stored in piles and usually loaded in to what are called cold-storage bins. The asphalt cement is stored in tanks so the temperature can be maintained. The aggregate is transported from the cold-storage bins to a revolving cylinder where it is dried and heated up. This revolving cylinder is typically 1.5 to 3 meters in diameter (5 to 10 feet) and 6 to 12 meters in length (20 to 40 feet). Unlike the drum-mix plants, the cylinder for the Batch plant is only used for the heating and drying of the aggregate. The rotating cylinder has “flights” which are basically shelves protruding from the cylinder which moves the asphalt through the

⁶⁸ There may be other firms that own quarries, but it was not evident from the listed owner. There is a Kay and Kay Quarry, but I could not find evidence that they were part of Kay & Kay Contracting. Source: Kentucky Transportation Cabinet. 2010b. "List of Approved Materials," Division of Materials, Frankfort, KY: Kentucky Transportation Cabinet,, May 25, 2010, <http://transportation.ky.gov/materials/>.

⁶⁹ Humrickhouse, Scott and Carol. Edwards. 1997. "Hot-Mix Asphalt Producers Monitor Profitability through Benchmarking," *Roads & Bridges*. Arlington Heights Illinois: Scranton Gillette Communications Inc.,

cylinder. A flame powered by oil or gas dries the aggregate and heats it up in preparation to be combined with the asphalt cement.⁷⁰ The cost of fuel to power the heater is one of the costs for running an asphalt plant. An exhaust fan creates a draft in the rotating cylinder which removes dust particles from the aggregate. This dust is then captured in bag houses and/or wet scrubbers and removed to decrease pollution emitted from the plant. Each plant must comply with air pollution guidelines and obtain the proper environmental operating permits to operate. The drying and heating can be one of the most costly parts of operating a plant due to the fact that oil or gas is needed to burn. At the end of the drying process the aggregate is checked for moisture and whether the temperature is in the desired range. The precise range of temperature depends on the design of the asphalt.⁷¹

The drying and heating of the aggregate is the most time consuming component of production and controls the speed at which new hot-mix asphalt can be produced. From the rotary dryer and heater the aggregate is then put in a hot elevator and then deposited on to a screening unit which divides up the aggregate into different size groups. The different sized aggregate is then held until it is dispensed into a weight hopper. The weight hopper is simply a container that weighs the aggregate before it is dispensed into the mixer. At this juncture in the process, the size and mixture of aggregate particles can be determined.⁷²

From the weight hopper the aggregate is dumped into a mixer or pugmill.⁷³ This mixer has mixing paddles that continually keep the aggregate moving. Asphalt cement is sprayed into the mixer and coats the aggregate. In order for proper mixture, both the asphalt cement and the aggregate must be at the proper temperature. These temperatures vary depending on the mixture and purpose of the asphalt. It is important that the aggregate is completely coated. Once this has occurred the hot-mix asphalt is deposited into insulated silos or into surge bins.⁷⁴

⁷⁰ There are two types of cylinders. Parallel flow dryers are cylinders where the aggregate and air flow in the same direction. These are typically used in Drum-Mix plants. The other type of cylinders are counter-flow dryers where the aggregate and air flow in opposite directions. These are typically found in Batch plants.

⁷¹ Asphalt Institute. 2000. *Construction of Hot Mix Asphalt Pavements*. Lexington, KY: Asphalt Institute.

⁷² Ibid.

⁷³ A pugmill varies in size and can hold from 1,800 to 7,200 kg (4,000 to 16,000 lbs) of hot-mix asphalt. Source: ibid.

⁷⁴ The insulated silos can hold the hot-mix asphalt at the proper temperature for up to 24 hours. The surge bins are for temporary storage. Source: ibid.

The hot-mix asphalt is then dispensed into trucks and weighed. This asphalt is then trucked to the project site to become the new pavement. During the production process, the asphalt is tested and inspected to ensure that it has the right consistency and properties for the job.⁷⁵

Drum-Mix plants

Many of the characteristics of a batch plant are similar to a drum-mix plant. However, instead of making one batch at a time, a drum-mix plant is continuously producing hot-mix asphalt. Instead of having a rotary cylinder for drying and heating and a separate pugmill for mixing, the drum-mix plant performs the drying, heating, and mixing in the drum mixer. The drum mixer is simply a one or two chamber rotary cylinder.⁷⁶ The aggregate is brought into the cylinder and like the batch plant the aggregate is rotated by “flights” and dried and heated. Instead of going into a different mixer, the aggregate goes to the bottom of the drum mixer and either is coated there with the hot asphalt cement or flows into a smaller chamber where mixing prongs keep the aggregate moving while the asphalt is sprayed onto the aggregate. The hot-mix asphalt is then deposited in silos or surge bins to wait being dispensed into trucks. Pollution and dust is removed in a similar manner to the batch plant.⁷⁷

Reclaimed asphalt pavement (RAP) can also be used in the both the batch plant and drum-mixer plants. However, the reclaimed asphalt pavement in the new asphalt mixtures can cause the final mixture to not meet the final specifications. When it is used there are limits, special precautions, and testing that are used to ensure the final mixture meets the specifications for the job.

2.3.4 Paving

The next step in process is the transportation of the asphalt from the asphalt plant to the project site. This is another source of high costs for a firm because of fuel costs, labor costs, and the potential of renting additional trucks when there are a lot of projects. The trucks that haul the hot-mix asphalt from the plant are usually either bottom-dump or end-dump trucks. The bed is usually metal, insulated and sprayed with a release agent which prevents the hot-mix

⁷⁵ Ibid.

⁷⁶ There are four types of drum mixers. The parallel flow dryer with coater, the counter flow dryer drum with a coater, double barrel drum mixer, and triple drum dryer/mixer. Source: *ibid*.

⁷⁷ *Ibid*.

asphalt from bonding with the truck bed. Each truck is equipped with a tarp that is used to cover the asphalt mixture to prevent cooling. The temperature of the asphalt mixture must remain above 85°C (185°F) until after it has been compacted. Hot-mix asphalt cannot be laid when there is rain or if the roadway is wet. If the roadway is wet and the hot-mix asphalt is laid it could prevent proper binding with the layer it is being laid on.⁷⁸ A general guideline is that hot-mix asphalt has 2 to 3 hours in an insulated truck before it falls below above 85°C (185°F).⁷⁹ However, an official of the Kentucky Transportation Cabinet stated that a more realistic time is between 45 to 60 minutes from the time the hot-mix asphalt is dispensed to when it is compacted. This time frame is important in determining the extent of a firm's service area or the area where they can reasonably complete asphalt paving projects.

At the project site a paver waits for the trucks with the hot-mix asphalt. A tractor pulls the paver which powers the paving unit. This unit is made up of a conveyor system, an auger, and a screed unit. The roadway has already been prepared with a prime or tack coat of liquid asphalt where the fresh hot-mix asphalt will be laid on. When the trucks arrive on-site with the hot-mix asphalt they back up to the paver and deposit the asphalt onto the conveyor system of the paver.⁸⁰ The hot-mix asphalt moves through the paver to the auger which distributes the mixture evenly along the screed. The screed unit is set to the specified depth for the project. The asphalt is deposited on the roadway, leveled, and slightly compacted by the screed unit.⁸¹ Pavers can be equipped with a screed unit that is capable of doing a single lane up to 9 meters (30 feet) or more.⁸²

The final step is the compaction of the asphalt. If all has gone according to plan, the hot-mix asphalt will still be above 85°C (185°F). Some asphalt mixtures need to be compacted at higher temperatures. These include mixtures designed with the Superpave method.⁸³ Once the asphalt

⁷⁸ Ibid.

⁷⁹ AASHTO; National Research Council (U.S.). Transportation Research Board.; United States. Army. Corps of Engineers. and United States. Federal Aviation Administration. 2000. *Hot-Mix Asphalt Paving Handbook 2000*. Washington, D.C.: US Army Corps of Engineers.

⁸⁰ A material transfer vehicle can also be used. This vehicle takes the asphalt from the truck and evenly deposits the hot-mix asphalt into the paver where the truck would normally unload. Source: Asphalt Institute. 2000. *Construction of Hot Mix Asphalt Pavements*. Lexington, KY: Asphalt Institute.

⁸¹ The screed unit is two pieces of metal set at a 90 degree angle. Source: *ibid*.

⁸² *Ibid*.

⁸³ The temperature these hot-mix asphalt needs to be compacted at is above 93°C (200°F). Source: *ibid*.

is laid it starts to cool quickly. The roller passes over the freshly laid hot-mix asphalt to compact the mixture to the right consistency. The reason why the aggregate particles must be angular is as the asphalt is being compacted the aggregate is able to interlock with other pieces which in turn support each other. This helps create the structure of the roadway. After the road has cooled, samples are taken and tested to see if the mixture has the properties of the mix design for the project and to ensure the quality of the new road.⁸⁴

2.4 Conclusion

This chapter details the history of bidding rigging in asphalt paving projects; the planning, design, funding, and bidding of a project; and the asphalt paving process. The important part of this chapter is to understand the institutional detail that leads to and helps firms tacitly collude. These aspects include projects being designated by county, the existence of service areas which limit the scope of the market, and the high-start up costs and economies of scale that limit firms from entering the market. Producing asphalt is a costly endeavor and can lead firms to seek after ways to increase their profit margin. The next chapter details the methods some firms use to tacitly collude to increase their profits.

Table 2.1: Number of firms awarded contracts and number of projects – 1994-2007

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Number of firms awarded contracts	41	37	39	35	36	34	46	50	40	33	34	38	33	37
Number of Projects	553	558	446	387	457	412	460	429	382	402	341	410	305	410

⁸⁴ Ibid.

3. CHAPTER 3: Collusion and Highway Procurement Auctions

This chapter focuses on the literature of collusion in highway procurement auctions and other research related to highway procurement auctions. The first section provides a broad overview of the literature related to collusion and auctions. The second and third sections of this chapter go in depth on a few specific articles directly dealing with collusion in asphalt paving and in estimation methods for this dissertation. Section 3.4 discusses the differences between overt and tacit collusion and focal points, while Section 3.5 discusses firm bidding behavior and tit-for-tat strategies.

3.1 Overview of the Literature

The explosion of federal investigations in the 1980s inspired literature investigating collusion and developing methods to identify collusive behavior. Feinstein et al. (1985) theoretically and empirically analyzed information asymmetries between highway construction cartels and the states that purchased their service. The results indicated that cartels seek to influence engineer's cost estimates through misinformation. They found that cartels are actively feeding the purchaser misinformation in order to change the purchasers' (the state) expectation on what constitutes a "good buy." Porter and Zona (1993) develop an econometric test to detect bid-rigging in highway procurement auctions. In their empirical analysis they focused specifically on auctions where there were more than two bids and if they could detect "phantom" bidding. A phantom bid is a bid that looks competitive because multiple firms are bidding. However, the choice of who the low and high bidders are was determined by the participating firms before the bids were submitted. This overt collusion gives the appearance that numerous firms are competing for a project, but the reality is the winner of the bid was predetermined.

Bajari and Ye (2003) developed econometric tools to detect collusive behavior and empirically analyzed data in Minnesota, North Dakota and South Dakota with seal-coating contracts. Their contribution is incorporating cost asymmetries among bidders into their model. These cost asymmetries arise due to location of the firms, capacity constraints or knowledge of local rules and regulations. They test for conditional independence to see if bids are independent and exchangeability to see if costs are actually driving bid levels and not just the presence of competitors. Lastly, they take into account industry experts' opinions about realistic distribution of markups to see if the market is competitive or collusive.

McAfee and McMillan (1992) theoretically look at bidding rings and detail how weak cartels and strong cartels function and maintain their collusive behavior.⁸⁵ Cartels use a mechanism such as “phases-of-the-moon” to determine who will win a particular auction bid. Also, there must be the ability to enforce the collusive behavior if there is deviation. They find that all members of the weak cartels submit the same bid, and they find that strong cartels can make transfer payments and not allow new entrants into the market (R. Preston McAfee and John McMillan, 1992). In this dissertation, collusion seems to take a different form where the individual players refuse to bid in a particular bid. The mechanism or focal points some asphalt firms use to maintain their territory are county boundaries

The literature on collusion has also extended into other areas including credit cards, hotels, electricity, timber and the dairy industry. Knittel and Stango analyze tacit collusion in the prices set by credit cards. They found that price regulation created a focal point that allowed tacit collusion prices that disappear with deregulation of credit card prices (Christopher R. Knittel and Victor Stango, 2003). Gan and Hernandez analyze tacit collusion in the hotel industry. The authors use a switching regression model and find clustered hotels are colluding during off-peak times (Li Gan and Manuel A. Hernandez, 2011). Fabra theoretically models tacit collusion in uniform-price and discriminatory auctions in a repeated setting which allows the firms to sustain collusive behavior. Her focus is on the electricity industry in England and Wales (Natalia Fabra, 2003). Michael K. Price extends the Bajari and Ye (2003) model into timber auctions in British Columbia and incorporates spatial distribution of bidders to try and detect collusion. He found evidence that perfectly competitive bidding patterns do not always exist when geographic space is accounted for. As distance between firms increases, bidding behavior becomes more competitive (Michael K. Price, 2008). Research has also focused on the milk bid-rigging of the 1980s and 1990s. Pesendorfer, Porter and Zona, Lanzillotti, and Scott analyze bid-rigging in Florida and Tennessee, Ohio, and Kentucky respectively (Robert Lanzillotti, 1996, Martin Pesendorfer, 2000, Robert H. Porter and J. Douglas Zona, 1999, Frank A. Scott, 2000).

Other literature focuses on factors that influence whether a firm bids on highway procurement projects and is used to control for factors that influence why a firm bids. The

⁸⁵ A weak cartel is unable to make transfer payments to other members of the cartel. The strong cartels are able to make transfer payments to each other.

authors Li and Zheng used a semiparametric Bayesian method to estimate distribution of entry cost, bidder's cost and controls for unobserved heterogeneity. Using a structural model they jointly estimate entry and bidding models and found that increases in potential bidders for highway mowing projects in Texas can lead to less aggressive bidding behavior and expected procurement costs may increase. This is a result of an "*entry effect*" and a "*competitive effect*", where the "*entry effect*" is where firms bid less aggressively with more firms and cause procurement costs to rise. Since firms realize their chances of winning a bid decrease with additional firms and it is costly to prepare a bid, the firms choose to bid less aggressively. If the "*entry effect*" is greater than the "*competitive effect*" then bids will actually rise with more potential bidders, and the authors found that, in auctions for mowing jobs, with more potential bidders the "*entry effect*" dominates the "*competitive effect*". The authors could not rule out collusion as the motivation behind this outcome, but they did not investigate it (Tong Li and Xiaoyong Zheng, 2009).

Hong and Shum investigate the "winner's curse" using data from New Jersey (1989-1997). The authors focus on three types of work which include highway work, bridge construction and maintenance, and road paving. They are particularly interested in common-value components (e.g. bridge work) of projects and how these impact whether firms bid or not. They find that non-paving jobs and bridge repair average costs rise as competition increases. These types of projects have common-cost uncertainty where a firm is not always clear how much a bridge project will cost and different firms may have different expectations of these costs. In contrast, in a private-value project such as asphalt paving, a firm has no uncertainty about costs for completing the project. The authors explain that firms who have overly optimistic information about the value of these common-value projects and win the bid may end up with negative expected profits (*winner's curse*). Therefore, a rational firm will not bid as aggressively if there are more competitors (*winner's curse effect*). An additional competitor lowers the bids (*competitive effect*) and firms' expectation of negative profits increases (*winner's curse effect*) as the additional firms enter the bidding. If the *winner's curse effect* is larger than the *competitive effect* then bid levels can actually increase as more firms enter (Han Hong and Matthew Shum, 2002).

De Silva et al. analyzed bidding patterns of entrants and incumbents and found that entrants bid more aggressively than incumbents. They also found that past winning and capacity

constraints all impact firms' bidding behavior. However, they did not find a strong relationship between distance and bidding behavior (Dakshina G De Silva et al., 2003). Jofre-Bonet and Pesendorfer analyzed repeated auctions and focused on how capacity constraints and firm efficiencies impact bidding behavior in California. They found that capacity constraints can increase costs to a firm (Mireia Jofre-Bonet and Martin Pesendorfer, 2003). De Silva et al. analyzed how winning one auction will increase the likelihood of winning another auction due to synergies associated with the projects in a dual-day auction (Dakshina G De Silva et al., 2005). Some of these factors were used in the creating the bid functions in this dissertation including distance and capacity constraints.

Other highway procurement auction literature focuses on how to account for unobserved heterogeneity in analyzing highway procurement auctions (Elena Krasnokutskaya, 2011), how time incentives impact construction project completion in Minnesota (Patrick Bajari and Gregory Lewis, 2009), and how bid preferences and discounts for small businesses impact behavior of large business bidding behavior in California (Elena Krasnokutskaya and Katja Seim, 2010, Justin Marion, 2007). Two papers find that making the engineer's cost estimate publicly available before the bid decreased the average bid level in Oklahoma (Dakshina G De Silva et al., 2008, Dakshina G De Silva et al., 2009b).

The current literature has focused on detecting overt collusion in highway procurement auctions. Other literature has looked at tacit collusion, but not specifically in asphalt paving. The other literature focuses on the determinants associated with a firm's decision to bid. However, what is lacking in the literature is a look at the determinants of single-bid contracts and its association with collusion. While De Silva et al. estimates the probability of entry they fail to include firms that could bid but choose not to buy the plans or bid proposal. It is often the case that projects with just one bid have firms that could reasonably complete the project but choose not to even participate. This is possibly the result of tacit collusion where firms are not illegally coordinating bids, but instead have come to "an understanding" about who should bid in a certain area. One contribution of this analysis to the literature will be to incorporate county lines to see how they influence whether a firm bids or not. The following sections reviews some of the key literature related to this dissertation. The next section discusses literature on collusion in highway procurement auctions. Section 3.3 focuses on other analyses in highway procurement auctions and how they relate to the analysis of this dissertation. Section 3.4

focuses on defining collusion and focal points, and section 3.5 discusses firms' bidding strategies.

3.2 Collusion in Highway Procurement Auctions

Feinstein et al. (1985) theoretically and empirically analyzed how highway construction cartels colluded. The results indicate that cartels seek to influence the engineer's cost estimate through misinformation. They find that cartels are actively feeding misinformation in order to change the purchasers' (the state) expectation on what constitutes a "good buy." In this model multiple contractors bid on projects from a single purchaser (government). Contractors make decisions based on expectations of the current period and future periods and can substitute demand among the periods because projects are substitutes for each other. In other words, contractors make decisions on current auctions based on expectations of how they will bid on future auctions depending if the price for the current auction is higher or lower than expected. The government can use the bids to gain information, and when contractors realize this information gathering is occurring they will form a cartel and feed misinformation to the government in an attempt to change the price expectations of the government.

Since information is distributed asymmetrically it is open to being manipulated by the cartel. The contractors have information about costs for materials, labor and the time it will take to complete a project. This information is not always available to the government which is purchasing the services of the contractor. If the firms band together and collude, then for each auction they can manipulate their bids to change the expectations of the government on what constitutes a "reasonable" bid in the future. In discussions with a transportation official in the Kentucky Transportation Cabinet, he pointed out that one problem the government has is knowing the costs of materials on a regular basis. The Kentucky contractors are in regular discussion with the subcontractors and will know what the market price is, but the officials who complete the engineer's estimate are not always aware of those prices. While it is possible that engineer's estimate manipulation is occurring in Kentucky, there is no evidence of overt collusion among the firms in Kentucky. The assumption made in this dissertation is that the engineer's estimate is reasonable and is a good estimate of the cost of the job.

This asymmetric information is what Feinstein, Block and Nold (1985) focus on in their theoretical and empirical models. The cartel can manipulate the government by raising the

bidding prices. One of their assumptions is that costs are fluctuating stochastically from period to period and so the bids will fluctuate also. The government also looks at past bidding results to form expectations of future low bids. In this way the cartel can use the fluctuations to their advantage and gradually ratchet the low bid up through time. The government will start to adjust expectations that the low bid should be higher, which ultimately benefits the collusive firms and leads to inefficiencies in the market. One important assumption that does not align with the analysis in this dissertation is that the authors assume that all of the contractors enter the cartel, and their method of manipulating the bids is by decreasing the variance of the bids in the short-run. In the long-run the cartel must be careful not to tip off the purchaser that they are manipulating the bids. They achieve this by making the market appear competitive. They can do this by manipulating the number of bidders and the variance of the bids in such a manner that makes it appear that the mean, variance, and “pool of bidder estimates” are normal and ultimately earn positive long-run profits. There is evidence that not all firms in Kentucky are engaged in tacit collusion and this results in firms who are competitive and keep the firms who are tacitly colluding in check. Also the problem is not that the market appears competitive, but that firms are refusing to bid which results in a high number of single-bid contracts.

The assumption of the model is that the government purchaser is using a rational expectations model. There are three strategic variables the cartel tries to manipulate: 1) the mean of the bids; 2) the variance of bids; and 3) the number of long-run market suppliers. The authors test this empirically using data from North Carolina between 1977 through 1979 due to the fact that government agencies letting the bids did not know or suspect collusion was occurring. From 1977 to 1982 there was active collusion among highway contractors and the U.S. Department of Justice filed more than 200 indictments. The data the authors analyzed contained collusive and non-collusive bids. The authors were able to contrast the competitive bids with the collusive bids while focusing specifically on the short-run. They normalized the bids by dividing the actual bid by the engineer’s estimate. They also regressed the normalized bids against unemployment to remove business cycle effects. To capture frequency of bidding they constructed an index that indicates how often a contractor bids with a particular group of contractors and then constructed an index variable for each contract. The independent variable in the regression is whether the bids on the project reflected collusion ($=1$) or competition ($=0$). They also included the variance of the bids. The results indicate that the contractors are actively

seeking to manipulate the government agencies through their bidding behavior as a cartel, the bids, and also the variance of the bids. (Jonathan S. Feinstein et al., 1985)

In contrast to the analysis of this dissertation, Feinstein, et al. focus on known overt collusive arrangements where firms are interacting and coordinating bids. Porter and Zona (1993) also know that collusion is occurring. They develop an econometric test to detect bid-rigging in highway procurement auctions. In their empirical analysis they focused specifically on auctions where there were more than two bids to see if they could detect “phantom” bidding. A phantom bid is a bid that looks competitive because multiple firms are bidding. In other words, the difference between the low bid and the second bid appear competitive. However, the choice of who the low and high bidders are was determined by the participating firms before the bids were submitted. This overt collusion gives the appearance that numerous firms are competing for a project in order to maintain the collusive behavior. This dissertation focuses on single-bid contracts and some of the reasons behind the high frequency of bids with only one bidder.

Porter and Zona focus on comparing the known collusive bids with the competitive bids for firms in New York. The data for their analysis is from Nassau and Suffolk counties in New York from April 1979-March 1985, and they focus specifically on contracts involving paving. The authors know which jobs are competitive and collusive. Joint bids and single-bids were excluded from the data set. The important variables include information on bidding, capacity constraints (constructed using job backlog data), a variable indicating whether or not a firm was a non-cartel firm who never won an auction, and a variable indicating whether or not the firm was located on Long Island. All of the cartel firms were on Long Island. They did not have engineer’s estimates of the projects. The dependent variable is the logarithm of the bid that a firm submitted for a particular job.

Using a firm’s expected probability of winning, they construct tests to check for phantom bidding. What the authors look for in the analysis is the stability of market shares and the distribution of bids. If collusive behavior is occurring, the market share would be more stable and the distribution of bids would have less variation. This is what the authors found. To arrive at this conclusion, the authors ran three regressions with a combined group, a competitive group, and a cartel group. Their results show that there are statistical differences between competitive firms and collusive firms in bidding. They found that the group of firms that are

collusively bidding use different methods and processes to determine the lowest bids versus the higher bids compared to the competitive bidders. This supports the hypothesis that phantom bidding is occurring and the higher bids are generated through the collusive behavior. Their main finding is that cartel bids do not coincide with costs. (Robert H. Porter and J. Douglas Zona, 1993)

While Feinstein et al. and Porter and Zone both knew that collusive behavior was occurring, Bajari and Ye (2003) developed econometric tools to try and detect collusive behavior. They empirically analyzed data in Minnesota, North Dakota, and South Dakota with seal-coating contracts from 1994-1998 with around 18,000 contracts. Their contributions include incorporating industry opinions and cost asymmetries among bidders into their model. These cost asymmetries arise due to location of the firms, capacity constraints, or knowledge of local rules and regulations. They test for conditional independence to see if bids are independent and exchangeability to see if costs are actually driving bid levels and not just the presence of competitors. The authors point out that the firms do not bid as aggressively against each other. Lastly, they take into account industry experts' opinions about realistic distribution of markups to see if the market is competitive or collusive. The industry experts give them what normal cost distributions would look like in the market. Then using Baye's theorem and the laws of conditional probability they see if the industry is competitive or collusive. They find three firms that fail the conditional independence and exchangeability tests. Then they incorporate the industry's opinion on cost distribution to try and determine if collusion is actually occurring. They find that the market appears to be competitive with limited evidence of collusion.

The authors looked at a procurement auction model with private value costs which means that the firms know their costs for competing on a project. Using the following variables, bid functions were created for all the firms. They included variables for distance, capacity utilization level (firm's total of winning bids to the time of the bid divided by firm's total of winning bids in the entire season), and concentration of the market. Competitor variables were also included such as maximum free capacity among competitors and minimal distance among competitors. The dependent variable for the bid function is the ratio of the bid divided by the engineer's estimate.

To test for conditional independence they split the market into two segments (top 11 firms and everyone else) and include auction fixed effects and then test for conditional independence

through hypothesis testing and observing the correlation coefficients. They do a Fisher test to test their hypothesis, and only find one set of firms who regularly bid against each other that violate the conditional independence test. The test for exchangeability means that the capacities and distances should enter in a “symmetric” way and they test this for the whole market and then for pairs of firms. They find another pair of firms from the exchangeability test. Some limitations are that they only have 138 auctions and they are concerned about omitted variable bias. One problem is that the cartel may be functioning in a way that may go undetected. The authors then construct and contrast three alternative structural models of the industry equilibrium. The first model is competitive while the second model has two firms colluding. This is the step that incorporates the industry expert’s opinion. They estimate the posterior probability of the market being competitive and collusive and their evidence seems to indicate that the market is competitive with limited evidence of collusion.(Patrick Bajari and Lixin Ye, 2003)

In contrast to these three papers on detecting collusion, my dissertation focuses on single-bid contracts, lack of competition, and the presence of tacit collusion in asphalt paving jobs in Kentucky. Feinstein et al. and Porter and Zona focus on methods of detecting overt collusion in highway paving after the collusive behavior has already been identified. Bajari and Ye focus on methodology to detect collusive behavior when it is not known whether it is occurring or not. Instead of the firms illegally colluding and making the market appear competitive, firms in Kentucky may simply refrain from bidding in certain counties thus leading to the high percentage of single-bid contracts and higher bid levels. It is not known at the time of analysis in this dissertation whether any overt collusive behavior is occurring or if federal authorities are investigating collusive behavior. My focus is determining if tacit collusion is one of the factors contributing to the high level of single-bid contracts. In order to identify tacit collusion, the focal point the firms use to coordinate their bidding must also be identified. This will be discussed in section 3.4. In the literature described previously, the authors looked at the methods and processes that were used to enable collusive behavior and to keep the collusive behavior secret. For this dissertation, the methods and process of coordinating bids are also laid out. One of the benefits of this analysis is that since this type of collusion is presumably not illegal, there is little effort to hide the methods and processes. While the other authors looked at the variation of bids and compare and contrast known cartel firms against competitive firms, my analysis focuses on where firms choose to bid and the factors that influence the firms’ decisions to bid.

In detecting tacit collusion, it is important to determine the focal point that is allowing the tacit collusion to occur (see Christopher R. Knittel and Victor Stango, 2003).

3.3 Estimation in Highway Procurement Auctions Analysis

In addition to the literature on collusive behavior in highway procurement auctions, there is literature related to highway procurement auctions which focuses on competition, capacity constraints, unobserved heterogeneity, preferences and incentives, and repeated auctions. Many of the methods used for the analysis for this dissertation originate from this literature. I only discuss the paper that is most closely related to the analysis of this dissertation in this section. Other literature was outlined in section 3.1.

De Silva et al. look at differences in bidding behavior for two project types (Dakshina G De Silva et al., 2009a). The first type of projects is common value jobs (e.g. bridge) where firms do not know how much the project will actually cost them to complete. This is due to unforeseen costs and problems outside their control.⁸⁶ The second type of projects are private value jobs (e.g. asphalt paving) where the firms know how much it will cost them to complete the project. In determining which category each project falls in, they calculate the share of each component (dollar value divided by engineer's estimate) and the component which had the highest share was used to classify the type of project.⁸⁷ For example if a project's largest component was the bridge construction it would be classified as a bridge project (common value job). In this dissertation analysis, the focus is only on jobs that are strictly asphalt paving jobs. This is largely because asphalt paving jobs have the highest level of single-bid projects. Projects with other components such as bridge, grade and drain, etc were excluded from this dissertation analysis. Parts of the methodology used by De Silva et al. were used to analyze firm bidding behavior.

⁸⁶ "Common value assets are assets where each buyer's valuation depends upon the information of all of the buyers. The canonical example of such assets are oil and gas leases. There is a component of the value of a tract that is common to all bidders, associated with the size of the deposit. However, bidders may have different information about deposit size and their development costs may differ." In a common value auction, a firm's bid is determined, in part, by the signals from their rivals. Source: Hendricks, Ken; Robert Porter and Guofu Tan. 2008. "Bidding Rings and the Winner's Curse." *The RAND Journal of Economics*, 39(4), 1018-41.

⁸⁷ Independent private value auctions "are auctions in which each buyer's valuation depends only upon her own information....In a private value auction, competition results in efficient trade because buyers bid whenever their value exceeds the reserve price, and their value is independent of their rival's signals." Source: *ibid.*

The authors use a two-stage estimation process for their analysis using data from January 2000 to August 2007 in Oklahoma and Texas. They use a probit model in the first stage to estimate the probability of a firm bidding on a project. The dependent variable is whether a firm submits a bid or not where they do not know how many rivals will be bidding. The analysis for this dissertation is a modification of this model. Instead of using a probit model a linear probability model is used to due to perfect classification that resulted when the Kentucky data was run using the probit model. The authors are interested in those firms who have shown an interest in the projects by purchasing the plans for the project. If a firm has not purchased the plans for the project then they are not included in the regression. The authors are interested in firms that have shown an interest, but then choose not to bid. I am interested in firms that do not purchase a plan/bid proposal, but could reasonably participate in the bidding. There are firms that could reasonably bid on a project, but do not show any interest in the projects (bid or purchase plans/bid proposals). The analysis in this dissertation is intended to understand if this refusal to bid or purchase bid proposals is due to tacit collusion.

The variables the authors use in their first model include four sets of variables. The first set of variables is auction characteristics. The second and third sets consist of variables to control for firm and rival firms characteristics. The fourth set of variables controls for the business environment. Some of these variables include the number of plan holders, the engineer's estimate, the number of project components, days to complete the project, a dummy variable identifying large firms, capacity utilization, distance to the project, bidding in a county with ongoing projects, rivals' past bidding to plan holder ratio, unemployment rate, volume of projects, and number of building permits. For the first estimation they cluster the standard errors by firms for the probit model. They find in the probit model that as the number of plan holders increases the probability of submitting a bid decreases for both types of projects. As distance increases the probability of bidding decreases and if the firm has a project in the same county the probability of bidding increases. The number of components also impacts whether a firm bids or not. One important difference between this model and the model for this dissertation is that instead of pooling all of the firms together in one probit model each firm had its own linear probability model. This allowed firm and geography concerns to be held constant. Also the number of variables was simplified down to distance from firm to project, capacity constraints, potential competitors for projects based on service areas, number of bid proposals purchased for the project, engineer's estimate, and the county variables. These are the

important determinants for whether a firm bids on a project. The second step of the De Silva et al. analysis was not used in the analysis of this dissertation.

The second stage is a fixed effects model with bid level as the dependent variable. The authors find that entry and competition in asphalt paving in Oklahoma is beneficial and can drive down bid levels, while there is no evidence of a significant competitive effect in bridge repair auctions. In the second model, they use the predicted number of bidders from the probit model to contrast with the expected number of bidders by using past histories. For the second model they focus specifically on the second-day auctions. The authors find that encouraging competition is beneficial and puts downward pressure on bids for projects with large shares of private value costs (asphalt). This result does not hold up for bridge projects (Dakshina G De Silva, Thomas D Jeitschko and Georgia Kosmopoulou, 2009a).

3.4 Overt versus Tacit Collusion

The type of coordination of bids or collusion that Feinstein et al. and Porter and Zona analyzed in their papers is overt collusion. The *Sherman Act* states: "Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States, or with foreign nations, is declared to be illegal."⁸⁸ This has been interpreted by the United States Department of Justice as including "agreements among competitors to fix prices, rig bids, and allocate customers, which are punishable as criminal felonies."⁸⁹ The Department of Justice identifies four types of bid rigging. Bid suppression is where competitors who could bid or did bid in the past agree to refrain from bidding. Complementary bidding is where some firms submit high bids to make the market appear competitive also called phantom bidding. According to the Department of Justice complementary bidding is the most common form of bid rigging. The next category is bid rotation where the firms rotate who wins the bid. The last category is subcontracting where firms who do not bid become subcontractors.⁹⁰ These are all forms of overt collusion because the firms make agreements to engage in bid rigging. The

⁸⁸ Section 1 of the Sherman Act; Source: "Sherman Act,"

http://www.law.cornell.edu/uscode/html/uscode15/usc_sec_15_00000001----000-.html.

⁸⁹ Antitrust Division, Department of Justice <http://www.justice.gov/atr/about/antitrust-laws.html>.

⁹⁰ Antitrust Division, Department of Justice. "Price Fixing, Bid Rigging, and Market Allocation Schemes: What They Are and What to Look For," <http://www.justice.gov/atr/public/guidelines/211578.htm>.

purpose of the bid rigging in procurement auctions is to raise bid levels and bring in more revenue to the firms.

The bid rigging that was discussed in Chapter 2 which was prosecuted by the Department of Justice in the 1980s in highway procurement auctions is a form of overt collusion. The firms would discuss who would be the winner of the bids and would rotate bids or pay off the determined losers. In contrast this dissertation analyzes to see if tacit collusion is occurring in asphalt paving in Kentucky.

The word “tacit” means “expressed or carried on without words or speech.”⁹¹ As opposed to overt collusion, tacit collusion is coordination of prices, output or bidding without explicit communication among the firms. When firms communicate regularly they are able to maintain the collusive agreement period after period. However, when firms do not communicate they must have some mechanism or strategy to coordinate bids period after period. This coordinating mechanism is called a focal point. A famous example of a focal point is used by Thomas Schelling. When students were asked where and when they would meet a stranger in New York City without communicating with that stranger, the overwhelming response was at Grand Central Station at noon. This example highlights that focal points are usually well known objects (Grand Central Stations) or commonly used meeting times (Noon). In order for firms to coordinate pricing or bidding without communicating, there needs to be a focal point that can be observed by all firms. In pricing the focal point may be a whole number like \$1,000 (David Besanko, 2010). Knittel and Stango found that credit cards coordinated prices at a non-binding price ceiling. This means that the prices of various firms were at a government-imposed price above the market price. The firms determined where to set their price based on this observable price ceiling (Christopher R. Knittel and Victor Stango, 2003).

Since the firms coordinate without communicating, tacit collusion has generally not been considered illegal. However, this is not a settled issue. Judge Stephen Beyer wrote:

Courts have noted that the Sherman Act prohibits *agreements*, and they have almost uniformly held, at least in the pricing area, that such individual pricing decisions (even when each firm rests its own decision upon its belief that competitors do the same) do *not* constitute an unlawful agreement under section 1 of the Sherman Act....That is not

⁹¹ "Tacit," *Merriam-Webster Dictionary*. <http://www.merriam-webster.com/dictionary/tacit>.

because such pricing is desirable (it is not), but because it is close to impossible to devise a judicially enforceable remedy for “interdependent” pricing. How does one order a firm to set its prices *without regard* to the likely reactions of its competitors?(Dennis A. Yao and Susan S. DeSanti, 1993)

The reason why tacit collusion cases are generally not prosecuted is because it is hard to distinguish if a firm is just following their own best strategy or actually engaging in agreement to manipulate prices. Also what a court defines what an “agreement” is can be open to interpretation. There are three important questions that need to be asked. (1) “How can one find an agreement if each firm has simply made an independent business decision, although one that is based on assessments of competitors’ likely conduct as well?” This highlights the fact that simply because firms refuse to bid against each other does not mean there is an agreement between the firms, but there still could be. (2) “How can one find culpability if a firm simply pursues its own best strategy, given the market circumstances that are present?” This pinpoints the fact that a firm may refuse to bid in a county, but they may be doing this to survive in a market and stay alive as a firm. (3) “Even if culpability were appropriate, what remedy would be workable—in other words, how could or should adjudicators order firms to ‘avoid’ conduct that is in their own independent best interests?” While the firms may be engaging in anticompetitive behavior, how do you “make” them bid on a project? There are not clear answers to these questions.(Dennis A. Yao and Susan S. DeSanti, 1993)

In order to help prosecutors decide whether an action rises to the merit of illegal action and should be prosecuted, the courts have come up with tests. The tests generally try help to avoid prosecuting conduct that “reflects a firm’s own self-interest.”⁹² This makes the prosecution of tacit collusive behavior tricky. There could be cases where there is clear anticompetitive behavior and prices increase due to this behavior. Under this test, courts could find businesses who are tacitly colluding guilty for violations of the Sherman Act. It depends on the interpretation of the court and if the prosecutors can show the actions are not part of the

⁹² Test 1: Whether there is motivation for an agreement or an agreement would benefit the alleged co-conspirators. Test 2: Whether there is an “independent” or “good business reason” for the challenged conduct. Test 3: Whether the conduct would be contrary to an alleged conspirator’s self-interest—i.e., would the conduct make individual business sense “but for” an hypothesis of joint action. Source: Yao, Dennis A. and Susan S. DeSanti. 1993. “Game Theory and the Legal Analysis of Tacit Collusion.” *The Antitrust Bulletin*, 38(113).

“firm’s own self-interest.” Interpretation of antitrust law is not solid or fixed, but changes with each new presidential administration and as courts and public opinions evolve.

In asphalt paving auctions in Kentucky, county boundaries serve as focal points that firms can use to coordinate bidding. Each firm can observe what county a project is located in, and the Kentucky Transportation Cabinet usually specifies an individual asphalt paving project within a single county since funding is usually allocated on a county basis. Firms can also observe if a rival firm has an asphalt plant located in a county and they can observe the bidding behavior of the other firm. These conditions allow the county boundaries to act as focal points to help firms coordinate their bidding with other firms. It is not hard to imagine that firms could adopt a strategy where they do not bid in a county where a rival firm has an asphalt plant or where a rival firm bids regularly. The other firms can also behave in a similar manner. This can develop into a tit-for-tat strategy as firms bid against each other repeatedly. This behavior will be discussed in the next section.

3.5 Repeated games and Tit-for-Tat behavior

The purpose of collusion is for firms to increase prices or bid levels to act like a monopolist and gain more revenue than they would in a competitive environment. The Department of Justice states that when “competitors collude, prices are inflated and the customer is cheated.” This price could be the winning bid for a highway procurement auction and the customer that is cheated could be the government. The Department of Justice also identifies conditions which may allow for collusive behavior to occur, which include a few sellers, standardized product, repetitive purchases, and firms who are familiar with one another.⁹³ While this is true for firms that engage in overt collusion, it is also true for firms that engage in tacit collusion.

The interaction between firms can be thought of as a strategic game. For firms that bid on projects, a firm’s bidding decision is a function of expected profits. These expected profits are dependent on costs and on revenues multiplied by the probability of winning the bid. The probability of winning a bid depends on the other firms who bid and the level of their bid. If there are a lot of firms bidding on a project, it would decrease the probability of the firm

⁹³ Antitrust Division, Department of Justice. "Price Fixing, Bid Rigging, and Market Allocation Schemes: What They Are and What to Look For," <http://www.justice.gov/atr/public/guidelines/211578.htm>.

winning the project and decrease expected profits. This interaction between asphalt firms can be represented by the prisoner's dilemma where a competitive outcome has smaller payoff than a cooperative outcome.⁹⁴

Assume that two firms in adjacent counties bid against each other in a one-period game. This is a sealed-bid auction where the lowest bid wins the contract. There is a cost to prepare and submit a bid. Firm U is located in County 1 and Firm V is located in County 2. There is one project up for auction located in County 1, and another project up for auction located in County 2. Each project is the same distance from each firm. The firms have two choices: cooperate or defect from cooperation. If both firms cooperate then Firm U will only bid on the project in County 1, and Firm V will only bid on the project in County 2. The expected profit for these two firms is 9 (see Figure 3.1 for a 2X2 payoff matrix). If, on the other hand, they both defect and compete against each other on both projects, then the competition drives the expected profit down to 1. There are two other possible outcomes. Firm U could defect while Firm V cooperates. In this circumstance, Firm U would win both projects and end up with an expected profit of 17. Firm V would have paid the cost to prepare and submit the project and would end up with an expected profit of -1. This is also the result if Firm V defects and Firm U cooperates.

The Nash equilibrium of the game is that both firms "defect" and compete. This seems counterintuitive since both firms would make more profit by cooperating and coordinating where they bid. However, "defect" is the dominate strategy for both firms, since both firms find the temptation of cheating more enticing since there is the possibility of earning a higher profit. When both firms "defect" the outcome is that expected profits are 1, which is significantly less than if they would have both played "cooperate." These results are only for a one period game.

If this game is repeated and played for an infinite or a finite number of periods with no known ending point then the cooperative strategy can become the dominant strategy. In order for the firms to "cooperate" the discount rate must be high enough to ensure that cheating now

⁹⁴ In the classic prisoner's dilemma, two people are arrested for a crime. They can either deny they took part in the crime or confess. If prisoner A confesses and prisoner B denies, then prisoner B would get a longer sentence than prisoner A. The same is true if prisoner A denies and prisoner B confesses. If both deny then they will get a shorter sentence than if they both confess. The Nash equilibrium is that both prisoners confess because they are afraid of a really long sentence if the other play confesses.

is not as profitable discounted for future periods (Avinash K. Dixit and Barry Nalebuff, 1991).⁹⁵ If firms cooperate in the first period, then this behavior can be maintained in future periods through a tit-for-tat strategy. To discover the best solution to a repeated prisoner's dilemma, Robert Axelrod constructed a computer tournament and had game theorists submit strategies. The winning strategy was the tit-for-tat strategy. He defines a tit-for-tat as a strategy of cooperating "on the first move and then doing whatever the other player did on the preceding move. Tit-for-tat is a strategy of cooperation based on reciprocity" (Robert M. Axelrod, 1984). There are four elements that make tit-for-tat an appealing and maintainable strategy. (1) It is "clear" and simple to understand. The firms cooperate and follow what the rival firm did last period. (2) It is "nice" in the sense that a firm would never initiate cheating. (3) If the rival firm does cheat then the firm is provoked and punishes the rival firm next period. (4) The firm also forgives and is willing to go back to the tit-for-strategy after the punishment has been given (Avinash K. Dixit and Barry Nalebuff, 1991).

Dixit and Nalebuff indicate there are problems with a tit-for-tat strategy. The major challenge of maintaining a tit-for-tat strategy is that a firm could misinterpret what a competitor is doing. An example would be an asphalt firm purchasing a bid proposal for a project in a rival firm's county. This could be misinterpreted by the rival firm as a threat that they might bid in the county even if they do not bid in that period. This could result in the rival firm bidding against the firm. This could snowball and result in the competitive outcome indefinitely. There is no clear point when the punishment phase would end or a clear mechanism that could bring the game back to the tit-for-tat strategy. If a firm is more prone to misinterpret a rival's motives, it may result in the tit-for-tat strategy being untenable (Avinash K. Dixit and Barry Nalebuff, 1991). Therefore, in order for the tit-for-tat strategy to be effective in the long-run, firms must not be prone to misinterpret a rival's action.

In a repeated game, firms may seek to soften competition. Tit-for-tat can be an outcome of a repeated game. In the context of this dissertation, a tit-for-tat strategy is characterized by firms not bidding against each other and if this unspoken agreement is broken then one of the firms retaliates against the other. Focal points may make a tit-for-tat strategy

⁹⁵ For the example in Figure 3.1 the discount rate needs to be greater than $\frac{1}{2}$ for firms to maintain cooperation now and in the future, and to make it not worth cheating in the first period.

easier to accomplish and cheating easier to detect (David Besanko, 2010). The focal points allow firms to know if the rival firm has bid in their territory. If they have then they can punish them the next period. In order for the punishment not to last for multiple periods, the punished firm must accept the punishment and not cheat in the next period and give no signal that can be misinterpreted as cheating. The firm that punished must be careful not to misinterpret their rival actions in future periods.

While tit-for-tat strategies are typically for games for infinite periods or for finite periods with no known ending period, there are cases where cooperation can occur when there are a known number of periods. Kreps, Milgrom, Roberts, and Wilson (1982) prove that there are circumstances where firms cooperate in a repeated prisoner's dilemma even if there are a finite number of periods. These periods of cooperation arise due to incomplete information between the two firms. In one model, a firm is not convinced that their rival will act rationally but will engage in a tit-for-tat behavior. They prove that in a sequential game the firms will cooperate in all but the "last few" periods. They also prove that cooperation can occur only if each firm believes the other firm will cooperate ((David M. Kreps Kreps et al., 1982). Andreoni and Miller (1993) empirically tested these findings. They used finitely repeated games and manipulated beliefs that opponents had about each other. In some cases they had a subject believe their opponent was more altruistic. The result is that in a sequential game a reputation model predicts cooperation between subjects. The subjects undertake efforts to appear altruistic. The results indicate that subjects cooperate and build their reputation as being altruistic. Cooperation was highest among people that were familiar with each other (James Andreoni and John H. Miller, 1993). This is a telling result and lends some insight in to why asphalt firms could maintain cooperative bidding. Asphalt paving companies bid against each other repeatedly and over time develop a bidding reputation. There may be peer pressure exerted from the firms to maintain an altruistic bidding strategy which includes cooperation. This may be requisite to remain in the "good boy's club." This peer pressure and resulting altruistic behavior would help dispel some of the misinterpretation that can destroy a tit-for-tat strategy. Firm's would be more forgiving if a firm cheats and could be more willing to come back to a cooperative strategy.

In summary, focal points allow the firms to coordinate their bidding by allowing the firms to determine when and where they will or will not bid. In Kentucky highway bidding, firms coordinate their bidding and engage in a tit-for-tat strategy by not bidding against each other.

Firms do not bid in each other's territories, and this refusal to bid is accomplished by being able to observe in what county the project is located and the bidding behavior of the other firms. As firms bid against one another month after month, the refusal to bid by a firm against a rival firm can be met in the next period by a refusal to bid by the rival firm. This tit-for-tat strategy can be played each time a project is up for bidding. If a rival cheats, then the firm could retaliate by bidding against them in the next period. This strategy is sensitive to misinterpretation of a rival's intention, and may end up being a competitive game if firms are not forgiving and revert back to the tit-for-tat strategy. If they are forgiving, this would allow the tit-for-tat strategy to continue in subsequent periods. The reputation of the firms and the peer pressure to maintain a cooperative environment allow the tit-for-tat strategy to continue period after period. If the firms are able to maintain this cooperative behavior it could lead to higher bid levels and higher profits for the firms involved.

3.6 Conclusion

In this chapter, the theoretical literature related to and used for this dissertation was discussed. This literature includes analysis of overt collusion in the asphalt paving industry and how firms coordinated bids. These firms made the bidding look competitive when in fact it was not. Other analysis has been done to try and detect collusion in the seal coating industry. There is also literature about what factors influence whether or not a firm bids on a highway procurement auction. This literature was used to construct the bid functions that are discussed in Chapter 5 and analyzed in Chapter 6. The purpose of the bid functions is to try and detect if firms are coordinating bids by using a focal point. The focal point can help firms engage in a tit-for-tat strategy where they refuse to bid in each other territories. This can lead to increases in bid levels and allow the firms engaging in this tit-for-tat strategy to exercise market power. A theoretical framework of this tacit collusion and the data used to analyze if tacit collusion is occurring is discussed in Chapter 4.

Figure 3.1: Prisoner's dilemma game in asphalt paving auction – One period

		Firm U	
		Cooperate	Defect
Firm V	Cooperate	9, 9	-1, 17
	Defect	17, -1	1, 1

4. CHAPTER 4: Theoretical Framework and Data

The purpose of this chapter is to lay out a theoretical framework which describes how firms in Kentucky could be engaging in tacit collusion. This follows the discussion in Chapter 3 about how firms use focal points to coordinate bidding and engage in a tit-for-tat behavior. The first section of this chapter focuses on the theoretical framework and motivation for this dissertation. It discusses four scenarios which illustrate how firms could use county boundaries to coordinate their bidding. The outcomes to these four scenarios are also discussed. The second section of the chapter focuses on the data that is used in Chapter 6 to analyze if firms are engaging in tacit collusion. The data section discusses the origins of the data and other factors that influence whether or not a firm will bid on a project. There is also a discussion of the variables that are used to in the empirical analysis to see if firms are using county boundaries to collude. The theory behind the county variables is discussed in section 4.1.

4.1 Theoretical Framework

As discussed in Chapter 3, the purpose of tacit collusion is to increase profits to a firm. This is accomplished by firms coordinating bids and acting like a monopolist. In order to accomplish this in a repeated game, firms use a focal point to coordinate bids and employ a tit-for-tat strategy to maintain this tacit collusion indefinitely. This section will discuss the theoretical underpinnings to this dissertation and the expected outcomes from the analysis that is detailed in Chapter 6.

4.1.1 Coordination of bidding in a repeated game

There are three main factors that can influence whether or not a firm bids on a project. The first is the cost of submitting a bid. This cost is endogenous to the firm and it can influence whether or not they submit the bid. The second is a random element. This is the fact that a firm may have a slightly lower cost to bid on a particular project due to some random variable. These random variables could be the fact the firm got a good deal on asphalt cement or aggregate, etc. The third part is a strategic factor. A firm may not know how a rival firm is going to bid on a project, and may attempt to coordinate with the rival firm. This strategic element of the bidding process is the factors that can lead to firms overtly or tacitly colluding. The purpose of this strategic behavior could be to raise bid levels so that firms can earn more profit. These factors will be discussed and used in the analysis for this dissertation.

The decision for Kentucky firms to bid on projects is a function of expected profits. The factors that influence expected profits and a firm's decision to bid include the costs to complete the project including transportation and labor costs and the amount of revenue they will get by completing the project. The higher the revenue the more likely a firm will be expected to bid on a project. However, if there is competition from other firms this will lower expected profits, because it will drive bid levels down to a level near costs. Firms in Kentucky bid against each other on a monthly basis over many years. If firms compete against each other on every project, it would drive expected profits down and may lead to firms exiting the market. The geographic area that an asphalt firm can service is limited due to the nature of hot-mix asphalt. This creates areas where only a few firms can reasonably compete against each other. The way to maximize expected profits in this oligopoly setting without communicating is to coordinate bids through a tit-for-tat strategy and the use of a focal point.

There are two institutional factors in Kentucky that could allow firms to coordinate their bidding and employ a tit-for-tat strategy. The first factor is the politically drawn county boundaries. These current county boundaries have been in place since 1940.⁹⁶ The county boundaries break Kentucky into 120 separate divisions that firms can identify and the boundaries of the counties do not change. The second factor is that the Kentucky Transportation Cabinet generally lets projects on a county basis. Each project is identified based on the county it is located in. If a project extends into two separate counties it is usually split into two different projects. Before a project is let, the firms know where the project is located. These two factors allow firms to easily identify the county a project is located in and if a rival firm has an asphalt plant located in that county. The county boundaries and location of a rival firm can be a focal point that allows firms to coordinate bidding with their rivals. In a repeated game the firms can use the county boundaries and location of rival firms to help them determine whether or not they should bid on a project. A tit-for-tat strategy can develop where firms do not bid in counties where the rival firms have an asphalt plant or where the rival firm regularly bids. In turn the rival firm would not bid on a project in a county where the firm has an asphalt plant or

⁹⁶ McCreary County was the last county created in 1912. Since that time there have only been minor changes to the boundaries between counties. The last minor change to the county boundaries was in Powell County in 1972. Source: "Kentucky: Individual County Chronologies," http://historical-county.newberry.org/website/Kentucky/documents/KY_Individual_County_Chronologies.htm.

bids. This tit-for-tat behavior allows the firm to avoid bidding against each other in a competitive manner. It softens competition which leads to bid levels above the competitive level. Thus, firms' expected profit increases and this strategy is able to be maintained period after period as long as firms only bid where they are "supposed" to bid. If firms cheat then this cheating can be punished by retaliation. The predicted results will be examined in the next section.

4.1.2 Predicted Outcomes

If firms are coordinating bids and employing a tit-for-tat strategy, the county boundaries are a prime candidate for the focal point that facilitates this coordination. Figure 4.1 through Figure 4.4 illustrates four county scenarios that exist in Kentucky. For each of these situations a competitive outcome will be discussed as well as an outcome where firms are coordinating bids. The generic firm of interest is Firm X and I will discuss their bidding behavior from their point of view. I will also discuss how rival firms react to each scenario so that a tit-for-tat strategy can be developed. It is important to remember that these are representations of scenarios firms may find themselves in, and that in reality there are more firms that could potentially be competing on projects in each county. However, the scenarios can be applied in the same manner with each additional rival firm. First, I will discuss the expected results without county boundaries.

WITHOUT COUNTY BOUNDARIES

If there were no identifiable political boundaries or focal points for firms to coordinate bids, then there are several factors that would influence whether a firm would bid on a project. These include the distance from the asphalt plant to the project. As the distance between the plant and project increases, the cost of servicing the project increases due to transportation costs. Another factor which influences whether or not a firm bids on the project is the size and scope of the project. Certain firms may not work on certain types of projects due to the requirements or the size of the project. Capacity constraints also can inhibit firms from bidding on projects. If a firm is working on the maximum amount of projects their equipment can handle, then it would cost more to rent trucks and other equipment to service an additional job.

There are also competitive factors that influence whether or not a firm would bid on a project. These include the number of potential competitors that would be bidding on the project. In a world without boundaries, firms could still use bid proposals that are published before the bidding takes place to see if rival firms are bidding on the project. Another

competitor factor is how close the rival firm is to the project. Firms could avoid bidding on projects that are “closer” to their rival firms. However, the definition of “closer to their rival firms” may vary throughout time and keep the market competitive.

All of these factors could influence whether a firm bids on a project. For some firms, distance may be the most important factors, while for other firms it could be the behavior of the competitor. In a world without political boundaries the factors that influence bidding on a project include distance, the size and scope of the project, capacity constraints, and competitor behavior. If there were no focal points for firms to use to coordinate bids, then cost and competitive factors would be the major factors which drive bidding behavior. When we add political boundaries and focal points in then the results can change. The following paragraphs will detail how firms can use county boundaries to coordinate bids.

SCENARIO 1 – Project in County A where Firm X is the only firm with an asphalt plant

In scenario 1, Firm X has an asphalt plant located in County A. Rival Firm Y has an asphalt plant located in County C. Project 1 is located in County A in the same county where Firm X has an asphalt plant (see Figure 4.1). Project 1 is located near the border of County A and County C. The project is about the same distance from both firms. Assuming both firms can service the project, the outcome in a competitive circumstance would be that both firms would bid on the project. The county boundaries would not be a factor in the firms bidding on the project. The other possible situation is if the firms are coordinating their bids then Rival Firm Y could refuse to bid on Project 1. The reason would be because it was in County A where Firm X has their asphalt plant. Firm X would bid on the project and win the contract for Project 1. In this way the firms can behave like monopolists in their pricing. This situation is easy to enforce since every project in County A would be bid on by Firm X and Rival Firm Y would always refuse to bid on the project. The county boundary and the fact that Firm X is located in County A serve as a focal point to coordinate their bidding. Scenario 2 discusses what happens when the project is located just across the border in County C.

SCENARIO 2 – Project in County C where Rival Firm Y has an asphalt plant

In scenario 2, Firm X has an asphalt plant located in County A. Rival Firm Y has an asphalt plant located in County C. Project 2 is located in County C in the same county where Rival Firm Y has an asphalt plant. Project 2 is located near the border of County A and County C (see Figure

4.2). The project is about the same distance from both firms. Assuming both firms can service the project, the outcome in a competitive circumstance would be that both firms would bid on the project. The county boundaries would not be a factor in the firms bidding on the project. The other possible situation is if the firms are coordinating their bids then Firm X could refuse to bid and not bid on Project 2. The reason would be because it was in County C where Rival Firm Y has their asphalt plant. Rival Firm Y would bid on the project and win the contract for Project 2. Looking at scenario 1 and 2 together a pattern emerges of tit-for-tat. Rival Firm Y does not bid in County A and Firm X does not bid in County C. If these two firms play this game repeatedly they would be able to sustain this coordination of bidding indefinitely. If, for instance, Firm X decided to bid in County C, Rival Firm Y would be able to know this and could retaliate in the next period by bidding on a project in County A. This tit-for-tat strategy and coordination of bidding is made possible because the county boundaries and the location of the firms in the county act as a focal point. Scenario 3 discusses what happens when another rival firm locates in County A.

SCENARIO 3 – Project in County A where Firm X and Rival Firm Z have asphalt plants

In scenario 3, Rival Firm Z has built an asphalt plant in County A. Firm X still has an asphalt plant located in County A. Rival Firm Y has an asphalt plant located in County C. Project 3 is located in County A in the same county where Firm X and Rival Firm Z have their asphalt plants (see Figure 4.3). Project 3 is located near the border of County A and County C. The project is about the same distance from all three firms. Assuming all three firms can service the project, the outcome in a competitive circumstance would be that all of the firms would bid on the project. The county boundaries would not be a factor in the firms bidding on the project. Another outcome is that Firm X and Rival Firm Z would bid on the project since it is located in County A while Rival Firm Y would not bid on the project. This could be because Rival Firm Y is coordinating bids with both firms in County A or one of the firms in County A. If Firm X refused to bid on another project in County C, then Firm X and Rival Firm Y are engaging in the tit-for-tat strategy. If Rival Firm Z also refused to bid on a project in County C, then Rival Firm Z and Rival Firm Y are also participating in the tit-for-tat strategy. On the other hand, if Rival Firm Z did bid on a project in County C then Rival Firm Z and Rival Firm Y are not engaging in the tit-for-tat strategy. This would be the same conclusion if Firm X bid on a project in County B. These results are summarized in Table 4.1.

What is not clear is how Firm X and Rival Firm Z would coordinate who would bid on Project 3. There is no clear boundary or focal point that would allow them to engage in this type of coordination. If this coordination is occurring it could be for other reasons such as cost factors, through observing who purchased bid proposals for the project, or through communication. The most likely outcome is that Firm X and Rival Firm Z will both bid on Project 3. Table 4.1 summarizes these results.

The key to these results is that for there to be tacit collusion both firms need to refuse to bid in each other's territories in a tit-for-tat strategy. This is facilitated with the county boundaries. It is also important to remember that in all these cases the other factors that influence a firm's bid needs to be controlled.

SCENARIO 4 – Project in County B where no firm has an asphalt plant

The last scenario is when a project is located in a county where no firms have an asphalt plant. In this scenario Firm X has an asphalt plant located in County A, and Rival Firm Y has an asphalt plant located in County C. Project 4 is located in County B in an adjacent county to both Firm X and Rival Firm Y. Project 4 is located about the same distance from both firms (see Figure 4.4). Assuming both firms can service the project, the outcome in a competitive circumstance would be that both firms would bid on the project. The county boundaries would not be a factor in the firms bidding on the project.

The other possible situation is if the firms are coordinating their bids. For example, Firm X could refuse to bid on Project 4. The reasons for them refusing to bid are not as clear as in scenario 2. The other situation is where Rival Firm Y does not bid on Project 4, and Firm X is the only bidder. It is not clear how one firm would become the dominant firm bidding on the project in County B. However, if one of the firms was established as the only bidder and claimed County B as their territory, then this could be maintained in a repeated game where one of the firms refuses to bid in County B. The difference between scenario 4 and the other scenarios is how firms would decide whose territory it belongs in. Since no firms have an asphalt plant, the only bidder could be determined by a firm being "nice" and allowing the other firm to claim the territory. It could also be determined by which firm historically has been the primary bidder in the county. A firm could also bid aggressively for a period of time to establish their claim on the

county. No matter how it comes about there is the possibility of firms coordinating who bids in County B; however, there is no clear cut result on which firm would be the only bidder.

These four scenarios provide some insight into how firms in Kentucky can engage in a tit-for-tat strategy by using the county boundaries and location of rival firm as a focal point to coordinate bidding. This tacit collusion could result in firms behaving like monopolists which could result in bid levels that are above the competitive level. Data was gathered for 31 firms in Kentucky to see if these firms are engaging in tacit collusion and to see how this tacit collusion takes place. The full analysis is done on a county-by-county basis and is found in Chapter 6. In the next section of this chapter, I discuss the data needed used in this analysis.

4.2 Data

4.2.1 Source of Data

The purpose of the empirical analysis is to see if firms are coordinating bids. The data used to analyze whether the firms are coordinating bids in asphalt paving projects in Kentucky is publicly available and was obtained from the Kentucky Transportation Cabinet for the years 2005-2007. These three years provide enough data to complete a thorough analysis of the bidding behavior of Kentucky asphalt firms. Data on contracts awarded, information on which firms purchased bid proposals, which firms actually bid on the projects, the amount of the bids, the firm that won, and the engineer's estimate were obtained from the KYTC Construction Procurement website.⁹⁷ This detailed data was only available after 2005 on the KYTC website. Upon request, the Kentucky Transportation Cabinet supplied project location information for the projects in Kentucky from 1996-2009.⁹⁸ The location information included latitude and longitude for the mid-point of each project, and according to KYTC is accurate for the time period of analysis, 2005-2007. These data also included information on the type of work including a short description of what the project entailed along with information about the road, location, and number of bids. This was supplemented with another data set from KYTC which contained all awarded contracts in Kentucky from 1994-2010.

⁹⁷ Only detailed information from 2005-2010 is available. Source: Construction Procurement, Kentucky Transportation Cabinet <http://transportation.ky.gov/contract>.

⁹⁸ In an email from a Transportation Cabinet official on April 23, 2010, he indicated that the latitude and longitude for the 2004-2009 data "should be fairly accurate" and is for the mid-point of the job. He indicated that the 1996-2003 data "aren't as accurate."

Information about plant locations came from various sources including the Plantmix Asphalt Industry of Kentucky (PAIKY) website, the Division of Materials within the Transportation Cabinet, from air quality permits obtained from the Division of Air Quality within the Environmental and Public Protection Cabinet, and from individual firm websites. For a few firms, the locations of the asphalt plants were confirmed over the phone. There are a total of 1,985 projects that were let and awarded from 2005-2007. In identifying asphalt projects, the data from KYTC contained a project label that briefly summarized the scope of the project. Using these variables, the asphalt paving projects were separated out from the other projects. In order to qualify as an asphalt project, the job cannot have any other element except asphalt resurfacing, surfacing, rehabilitation, or patching. An asphalt project that had grade and drain, bridge or guardrail components were not included in the “asphalt” projects for this analysis. Also 24 projects that were classified as multi-county of “various county” were excluded from the data set since this analysis focuses on projects identified for a specific county. This left 1,075 asphalt projects for this analysis. These projects account for around \$600 million in expenditures by the Kentucky Transportation Cabinet.

4.2.2 Bid Data

Sixty-three percent of the projects only had one bidder, and 90 percent had one or two bidders. The winning bids for single-bid projects in asphalt jobs average 2.22 percent over the engineer’s estimate, while multi-bid projects average 14.28 percent below the engineer’s estimate. It is clear that competition drops the bid level significantly. These numbers lend evidence to the fact that firms who are the winning bidder for single-bid contracts behave like monopolists and are able to raise bids above the competitive level. The underlining question is whether or not the firms are able to win single-bid contracts because they are coordinating bids with the rival firms. If the firms were not coordinating bids we would expect the bid levels to be closer to the competitive level simply because there is still the threat of competition. The other firm may not have bid on the project for other reasons associated with the cost to service the project.

Looking at the bidding behavior of four firms in the Lexington Kentucky area shows some of the patterns of bidding behavior that are seen in Kentucky. The counties in Figure 4.5 are Fayette County where Lexington, Kentucky is located, Scott, Bourbon, and Clark Counties. The red dots indicate where a firm has bid on a project and the gray dots indicate a project where

the firm did not bid. What stands out is that each four of these firms stick to bidding in their own counties. Most of the projects in Figure 4.5 are single-bid contracts. These four firms and their bidding behavior are looked at more in-depth in Chapter 6. The point of Figure 4.5 is that the data shows that some factor is driving firms to not bid in other firm's counties. The overarching purpose of this analysis is to determine the factors behind the single-bid contracts and lack of competition in asphalt paving jobs in Kentucky. The following paragraphs detail information about the firms and how the variables were constructed.

4.2.3 Firms

There are 31 major firms that bid on asphalt paving projects in Kentucky. Table 4.2 lists the names of the 31 firms, the number of asphalt plants each firm operates, the number of asphalt projects they bid on in Kentucky, the percentage of the those bids where the firm is the lone bidder, the number of contracts the firm won, and the value of the contracted projects. Typically the firms with more asphalt plants bid on and win more projects.

However, firms like H&G Construction bid on 77 projects and only have one asphalt plant. They only won 14 of those projects, and they were never the only bidder on the project. They compete against Jim Smith Contracting and Murray Paving on projects. Scotty's Contracting and Stone won over \$69 million in contracts during 2005-2007. Only two firms, ATS Construction and Nally & Gibson Georgetown, won all of the projects they bid on. There are also some additional firms that occasionally bid on projects but they were not included due to lack of frequency of bidding or lack of other information about the firm. These firms include Burton Paving, Certified Construction of Kentucky, and Kenway Paving. There are also firms in Indiana that bid on projects including E&B Paving, Gohmann Asphalt, J.H. Randolph, and Mac Construction. These firms were not formally incorporated into this analysis since the analysis focuses specifically on firms that have asphalt plants in Kentucky. However, these firms are mentioned and discussed in Chapter 6.

4.2.4 Counties

The 31 Kentucky firms have a total of 113 asphalt plants in the 120 Kentucky counties for an average of 0.94 plants per county. In 60 percent of counties in Kentucky, there is only one firm with asphalt plants in the county (see Figure 4.6). Thirty-two percent of the counties have no asphalt plants. In more urban areas such as Louisville there are two or three asphalt plants in

the county. Figure 4.6 shows the location of the 31 firms' asphalt plants that were analyzed in this dissertation. The more rural areas typically have one asphalt plant per county. Urban areas such as Northern Kentucky and the Louisville area typically have two or more firms in a county. Around 92 percent of the counties in Kentucky have zero or only one firm with an asphalt plant(s).

In general the distribution of asphalt plants in the various states depends on the population and size of the counties. More urban areas typically have more asphalt plants because there are more jobs. Rural areas typically have less asphalt plants, and there are counties without asphalt plants. In a lot of ways the distribution of asphalt plants in Kentucky is similar to a lot of states in the United States and firms have fixed service areas. For example, in Mississippi the distribution of asphalt plants is similar to Kentucky. See appendix for a map of asphalt plants in Mississippi. However, some asphalt firms have portable asphalt plants and this greatly expands their service areas. In Montana, firms have portable asphalt plants which make the firms more mobile and able to do projects in different locations throughout the state of Montana. Firms that have portable asphalt plants do not have confined, fixed service areas.

Like Kentucky, Mississippi has a high number of single-bid contracts in asphalt paving.⁹⁹ In Mississippi, there are 59 asphalt plants in the 82 counties for an average of 0.72 plants per county.¹⁰⁰ Forty-six percent of the Mississippi counties have no asphalt plants, while 46 percent have only one firm with asphalt plants in the county. The other eight percent of counties have multiple firms with asphalt plants in the county. The distribution of asphalt plants throughout Mississippi is similar to Kentucky. On the other hand, according to the AASHTO survey only 10 percent of the asphalt resurfacing projects in South Carolina has one bidder. In 2001, South Carolina had 55 asphalt plants in 46 counties.¹⁰¹ That is an average 1.2 asphalt plants per county.

⁹⁹ According to the AASHTO survey, over 70 percent of asphalt paving projects in Mississippi was single-bid contracts. Maine is also similar; however asphalt plant locations could not be determined in a timely manner. The cost in terms of time to find asphalt plant locations in Maine was prohibitive and not undertaken for this dissertation.

¹⁰⁰ See Appendix for a map of asphalt plant locations in Mississippi. Source: "2010 Mapa Plant Location Map," Mississippi Asphalt Pavement Association, www.superpave.com/location-map/.

¹⁰¹ This information comes from an audit of asphalt paving in South Carolina in 2001. Source: Council, South Carolina Legislative Audit. 2001. "A Review of Competition for the Department of Transportation's Road Paving Contracts," D. o. Transportation,

Thirty-four percent of the counties in South Carolina have no asphalt plants, and only 18 percent of the counties have one firm with asphalt plants in the county. In contrast to Kentucky and Mississippi, 31 percent of South Carolina's counties have multiple firms with asphalt plants. It is interesting to note that in 92 percent of both Kentucky and Mississippi counties there are either zero asphalt plants or one firm with asphalt plants in the county. This percentage drops to 64 percent for South Carolina. The fact that South Carolina has more counties with multiple firms could contribute to their lower level of single-bid contracts in asphalt paving.¹⁰²

While the distribution of firms is important to how firms coordinate bids, practices within the Kentucky Transportation Cabinet make the county an important focal point in bidding. KYTC usually limits asphalt projects to within the borders of one county. Both federal and state funding is usually designated on a county basis.¹⁰³ This results in a project being located in only one county. This enables firms to know which projects will be in which county. This further enforces the importance of the counties in bidding on projects. For example, two projects on KY 160 were let for bidding on April 30, 2007. These two projects were located only seven miles from each other. Instead of combining the two projects into one project, they were kept separate because they were located in two different counties. The cost of a firm to service the two projects together would be minimal. This practice of confining a project to one county by KYTC results in political boundaries becoming a visual focal point that a firm can use to determine whether they will bid on a project.

Other states also let asphalt paving projects by county. Thirty-six out of the 50 states classify most of their projects by county (See appendix for list of all 50 states). Six states have a large number of asphalt projects that span multiple counties and also have some asphalt projects that are confined in one county. There are some states, such as California, where I could not find

¹⁰² Ohio has over 300 asphalt plants and 88 counties. Source: The Associated Press. 2004. "Asphalt Makers Studied: Epa Action Now Includes 5 States, but Reason Not Apparent " *Cincinnati Enquirer*. Cincinnati, OH: http://www.enquirer.com/editions/2004/07/06/loc_loc1oasph.html.

¹⁰³ The exact wording from the design manual is as follows: "When a roadway project crosses boundaries, such as county or rural-urban, funding separations may also be required. Federal project funds are separated by county or by rural-urban boundaries, with different federal project numbers when two or more are required, and by participating and nonparticipating quantities when applicable. A roadway project crossing county boundaries requires separation of state project funds only. Tie all boundary lines to the project centerline by station and bearing. Separate and summarize quantities for each section." Source: Kentucky Transportation Cabinet. 2006a. *Highway Design Guidance Manual*. Frankfort, Kentucky: Kentucky Transportation Cabinet.

evidence that projects were designated by county. Most states focus the project on the county level, but the majority of them do not have the high number of single-bid projects that Kentucky has. There are other factors that contribute to this behavior.

Another factor that makes the counties good focal points are their size. The average size of Kentucky counties, compared to other states, is small.¹⁰⁴ Therefore an asphalt plant can easily service any project within the county boundary. This creates an environment where firms can carve out territories by “claiming” certain counties as their own.

4.2.5 *Districts*

The Kentucky Transportation Cabinet breaks Kentucky into 12 districts with about 10 counties per district. These districts were used in this dissertation to help organize the analysis in Chapter 6. Table 4.3 shows the breakdown of projects, contracted value of those projects, and the average number of bidders by district. District 5 and 6 has the highest average of bidders. These districts comprise the Louisville area (District 5) and the Northern Kentucky area (District 6). District 10 in Eastern Kentucky has the lowest average number of bidders per project. Figure 4.7 shows the boundaries of each district.

4.2.6 *Service Areas*

Political boundaries such as county boundaries and district boundaries do not necessarily align with a firm’s boundaries. In asphalt paving, the service area is the area where a firm can reasonably service any asphalt project. This area is restricted based on the factors discussed in Chapter 2. A firm’s service area is defined as the area where firms can reasonably complete an asphalt paving job without the hot-mix asphalt cooling below the temperature threshold (around 85°C or 185°F). Originally the plan was to determine service areas for firm asphalt plants based on a standard drive time ranging from 45 to 60 minutes from the plant to a project. This is the typical period of time, identified by KYTC, when hot-mix asphalt will remain hot enough to set correctly when it is laid and compacted. The U.S Army Corps of Engineers says this time frame can be two to three hours in an insulated and covered truck. When looking at

¹⁰⁴ The average square miles per county (336.8) in Kentucky is ranked 49th among all 50 states. Rhode Island which has five counties is 50th with the smallest average square miles per county. Kentucky has 120 counties and ranks 3rd among the 50 states for the number of counties. Only Georgia and Texas have more counties.

the distance from plants to projects for projects the firms bid on, only one firm bid on projects beyond 60 miles. Road Builders & Parkway Construction bid on a project in Madison County over 180 miles from their asphalt plant in Muhlenberg County. Since this is unusual, the service area for every firm was set at 60 driving miles from each firm's asphalt plant.

All mapping analysis was done in the ArcGIS ArcMap program using the Network Analyst function.¹⁰⁵ I was able to determine and calculate the service areas and driving distance from asphalt plant to project. The software also mapped out these 60 mile service areas. Figure 4.8 shows H&G Construction's service area and the projects they bid on in the service area. The different 10-mile bands indicate distance from their asphalt plant in Graves County. Notice in Livingston County they bid on a project that is almost 60 miles away from their asphalt plant. Since no firms bid on any projects beyond 60 miles, except the one mentioned earlier, it was a natural cutoff for the service areas. It also fits within the time parameters outlined earlier.

All of the projects in each firm's individual service area were included in the analysis for each firm. Each individual project located in a firm's service area is a unit of observation. The question of interest in this analysis is to try and determine the factors that contribute to why a firm bids or does not bid on a project in their service area. These include cost factors such as distance from plant to project, the number of projects a firm has under contract, and the size of the project. Since firms are competing in a repeated game, competitor factors are included. These variables include how many firms purchased bid proposals and how many competitors have the project in their service area. Lastly, county variables were added to see if any of the firms are using county boundaries as focal points to coordinate their bidding. More information regarding these variables is contained in the next few sections. With these variables a bid function was constructed for each firm. These bid functions will be discussed in Chapter 5.

¹⁰⁵ The ArcGIS ArcMap software by ESRI is mapping software. This software allowed me to map the asphalt plants and project locations. This was done by inputting the latitude and longitude of the plants and projects and the software mapped the location. The road map for Kentucky was obtained from the Kentucky Transportation Cabinet. The Kentucky map was uploaded into the software and used in all of the analysis. This map includes data indicating road length. The mapping software is able to calculate "as-the-crow-flies", driving distances, and other distance measures. The software can also be used to draw the shortest route from point "A" to point "B". It can also map distance circles outward from a certain point. These functionalities were used in the analysis of this dissertation.

4.2.7 Dependent and Independent Variables

As discussed in the previous section, each unit of observation is a project located within a firm's service area. The dependent variable for the regression is equal to one if the firm bid on a project and 0 otherwise. As shown in Table 4.2, one firm bid on only 4 projects while another bid on 150 projects located in their service area. There are also other projects contained in their 60 mile service area they did not bid on. Figure 4.8 for H&G Construction shows the projects they bid on and did not bid on. All of these projects within the 60 mile service area were included in H&G Construction's analysis. This applies to the other 30 firms. This analysis is trying to understand the factors that influence why a firm bids or does not bid on the projects in their service area.

The first set of variables is associated with the costs that may influence whether or not a firm will bid on a project. After determining the projects that fall within the firm's service area, the driving distance from the plant to the project was calculated using the OD Cost Matrix function in ArcMap. This mapping function calculated the shortest driving distance from a plant to each and every project in the service area using maps publicly available from the Kentucky Transportation Cabinet. Each length of road is measured in miles and the software package determines driving distances from the asphalt plant to the project. Distance is a major reason why firms do not bid on a project and is included to control for costs associated with a project being farther away. If firms are not tacitly colluding, we would expect the distance variable to be the most important factor behind a firm's bid. However, if firms are tacitly colluding then a county boundary may affect the probability of bidding when distance is held constant.

The capacity constraint variable is included to see if a firm's workload inhibits their bidding on a project. If a firm is at or close to their maximum capacity, it increases the costs to work on other jobs since they may have to rent additional trucks, etc. In constructing this variable, the capacity constraint for a firm is the amount of projects the firm is currently working on (falls between the beginning and ending date) on the day of bidding. For example, Mountain Enterprises bid on a project on November 11, 2007. A search of the awarded contract data

indicates that the firm had seven projects under contract on this day.¹⁰⁶ This data exercise was replicated for each project for each firm. Another independent variable is the engineer's estimate which is used to control for heterogeneity between projects. Not all projects are exactly the same and this variable controls for these differences. This variable also lends insight into a firm's strategic behavior and the types of projects they are willing to bid on. Some firms may be more interested in higher value projects while others are interested in lower-value projects.

The second set of variables is the competitor variables. A variable was created which counted the number of competitor 60 mile service areas a project falls in. This variable measures the number of potential competitors the firm faces when bidding on a project. The other competitor variable is the number of bid proposals competitors purchased for the project. This variable was included to see if competitor firms purchasing bid proposals deterred bidding or increased the probability of a firm bidding. This variable controls for the firm's strategic behavior that may result when they observe who has purchased a bid proposal for the project. Each firm must purchase a bid proposal to bid on a project and these bid proposals are publically available before the bid.

4.2.8 County Variables

The third and final set of variables is the county variables. These variables are used in the analysis to see if firms are using county boundaries as a focal point to tacitly collude. The variables of interest for this analysis are the county variables. In determining if tacit collusion exists, I hypothesize that county lines act as a focal point for whether a firm will bid on a project or not. The different firms then use these county boundaries to coordinate bidding behavior in a tit-for-tat strategy as described in section 4.1 of this chapter. Since Kentucky counties are relatively small, an asphalt plant can easily service any project within the boundaries of several counties. This creates an environment where firms can carve out territories by "claiming" certain counties as their own. There are enough projects within this territory to sustain their business, and, with other firms not bidding, allows a firm to elevate their bid above competitive

¹⁰⁶ In order to determine the number of projects in process, a complex "IF" command in Microsoft Excel was used. This formula evaluated the beginning and ending dates of each project and determined how many projects included the current bid date, e.g. November 11, 2007.

levels. The relative size of counties and the fact that projects are classified by counties create an environment where firms can use the county boundaries as focal points to sustain their territory and coordinate bids with other rival firms. To test this hypothesis, four county dummy variables were constructed to replicate the four scenarios described in section 4.1.

The first variable is *Project in same county – no rival*. This variable indicates a project is located in the county where the firm has their asphalt plant (see scenario 1). The second variable is *Project in same county – rival*. This variable indicates that a project is located in the county where the firm has an asphalt plant and a rival firm has an asphalt plant in that same county (see scenario 3). The third variable is *Project in adjacent county – no rival*. This variable indicates a project is located in a county adjacent to the county where the firm has their asphalt plant. It also indicates that the county does not have a rival asphalt plant (see scenario 4). The fourth variable is *Project in adjacent county –rival*. This variable indicates a project is located in a county adjacent to the county where the firm has their asphalt plant. It indicates that a rival firm has an asphalt plant in the county (see scenario 2). These four variables will be used to see if the firms are using the county boundaries to coordinate their bidding. Specifically, I am interested if firms refuse to bid on projects simply because it is in the territory of their rivals. How this analysis is done is described in Chapter 5.

4.3 Conclusion

In conclusion, the theoretical framework in section 4.1 shows that firms can use the county boundaries to coordinate their bids. This is accomplished by firms not bidding in each other's counties where the rival firm has an asphalt plant or bids regularly. If the firms cheat they can punish the other firm through retaliatory bidding. If there are no firms located in a county then the outcome is more uncertain if there will be tacit collusion or not. This refusal to bid in each other's counties is a tit-for-tat strategy where firms seek to increase bid levels above the competitive level and increase profits. This strategy can be maintained in a repeated game since the focal point of county boundaries is helped by the fact that KYTC lets projects in specific counties.

The question of interest is whether or not firms are using county boundaries to tacitly collude. The data used to answer this question comes from publically available bid data obtained from the Kentucky Transportation Cabinet. The unit of observation is asphalt paving

projects from 2005-2007 in Kentucky. All of these projects fall within a firm's 60 mile service area. In order to answer the question of interest, it is important to control for other factors that might influence whether or not a firm bids on a project. These include distance from asphalt plant to project, the number of jobs under contract, the size and scope of the project, and the potential competitors. County variables were created following the theoretical framework in the first half of the chapter. These variables are combined into individual bid functions to see if firms are tacitly colluding. The bid functions are discussed in Chapter 5 and the results are discussed in Chapter 6.

Table 4.1: Different outcomes for Scenario 3

Firm	Action	Firm	Action	Conclusion
Firm X and Rival Firm Y				
Firm X	Bids in County A; Bids in County C	Rival Firm Y	Bids in County A; Bids in County C	Competitive
Firm X	Bids in County A; does not bid in County C	Rival Firm Y	Does not bid on in County A; bids in County C	Collusion
Firm X	Bids in County A; bids in County C	Rival Firm Y	Does not bid on in County A; bids in County C	No collusion
Firm X	Bids in County A; does not bid in County C	Rival Firm Y	Bids on in County A; bids in County C	No collusion
Firm X and Rival Firm Z				
Firm X	Bids in County A	Rival Firm Z	Bids on in County A	Competitive
Firm X	Bids in County A	Rival Firm Z	Does not bid on in County A	?
Firm X	Does not bid on in County A	Rival Firm Z	Bids in County A	?
Rival Firm Z and Rival Firm Y				
Rival Firm Z	Bids in County A; Bids in County C	Rival Firm Y	Bids in County A; Bids in County C	Competitive
Rival Firm Z	Bids in County A; does not bid in County C	Rival Firm Y	Does not bid on in County A; bids in County C	Collusion
Rival Firm Z	Bids in County A; bids in County C	Rival Firm Y	Does not bid on in County A; bids in County C	No collusion
Rival Firm Z	Bids in County A; does not bid in County C	Rival Firm Y	Bids on in County A; bids in County C	No collusion

Table 4.2: Firm bidding and the value of winning contracts

Firms	Number of Plants	Asphalt Paving Projects Bid on		Asphalt Paving Contracts Won	
		Number of Bids	Firm only bidder on project (%)	Number of Projects Won	Contracted Value of Winning Projects (\$)
THE ALLEN COMPANY INC	3	54	50	49	15,308,473.15
ATS CONSTRUCTION	2	21	100	21	39,934,777.30
BARRETT PAVING MATERIALS INC	3	63	0	16	4,376,192.58
BLACKTOP INDUSTRIES & EQUIPMENT COMPANY	1	11	0	2	528,974.50
BLUEGRASS PAVING	1	31	0	8	2,227,065.31
COMMERCIAL PAVERS INC	3	53	0	24	18,353,377.60
EATON ASPHALT PAVING CO INC	5	99	3	43	12,210,883.50
ELMO GREER & SONS LLC	10	69	55	66	34,306,098.30
FLYNN BROTHERS CONTRACTING INC	2	31	0	6	2,987,221.00
GADDIE-SHAMROCK LLC	3	29	79	28	26,117,688.71
GLASS PAVING INC	2	20	70	16	10,558,645.85
H & G CONSTRUCTION COMPANY INC	1	77	0	14	6,106,025.76
H G MAYS CORPORATION	3	38	45	32	16,388,222.00
HINKLE CONTRACTING CORPORATION	11	107	92	103	51,571,836.47
JIM SMITH CONTRACTING COMPANY LLC	3	86	14	71	28,711,260.19
KAY & KAY CONTRACTING LLC	1	33	0	3	719,879.00
LEXINGTON QUARRY COMPANY	1	17	76	14	7,117,499.10
LINCOLN COUNTY READY MIX INC	1	28	0	5	2,226,384.48
MAGO CONSTRUCTION COMPANY LLC	12	102	46	88	38,670,973.43
MOUNTAIN ENTERPRISES INC	13	150	87	144	77,543,544.78
MURRAY PAVING	1	4	25	4	1,765,535.60
NALLY & GIBSON GEORGETOWN LLC D/B/A	1	11	100	11	4,804,703.60
NALLY & HAYDON SURFACING LLC	3	30	97	30	12,967,285.12
OHIO VALLEY ASPHALT LLC	3	33	39	27	7,344,865.32
QUALIFIED PAVING LLC	1	17	0	10	7,281,674.44
ROAD BUILDERS & PARKWAY CONSTRUCTION LLC	2	38	76	33	24,192,496.38
ROGERS GROUP INC	5	55	71	50	37,252,115.20
SCOTTY'S CONTRACTING AND STONE LLC	12	119	61	96	69,271,902.25
SHELBYVILLE ASPHALT COMPANY LLC	1	6	17	3	692,378.10
THE WALKER COMPANY OF KENTUCKY INC	2	22	86	21	7,110,045.55
YAGER MATERIALS LLC	1	28	68	21	24,133,747.90

Table 4.3: Average number of bids per project by district

DISTRICT	All Projects			
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Avg. Number of Bidders
DISTRICT 1	104	\$ 42,021,541.51	-4.27	1.74
DISTRICT 2	106	\$102,776,730.11	-0.43	1.33
DISTRICT 3	73	\$ 41,946,003.93	-3.02	1.15
DISTRICT 4	90	\$ 53,146,971.36	-6.73	1.56
DISTRICT 5	86	\$ 50,046,331.40	-11.28	2.57
DISTRICT 6	112	\$ 31,300,693.02	-11.86	2.11
DISTRICT 7	121	\$ 78,252,441.29	-2.00	1.19
DISTRICT 8	73	\$ 46,557,682.24	-4.76	1.30
DISTRICT 9	76	\$ 45,306,050.18	-3.63	1.33
DISTRICT 10	78	\$ 27,641,076.56	4.02	1.04
DISTRICT 11	82	\$ 50,248,009.84	-4.01	1.33
DISTRICT 12	74	\$ 39,558,747.79	4.89	1.08
TOTAL	1075	\$608,802,279.23	-3.84	1.50

Figure 4.1: Project in same county without rival

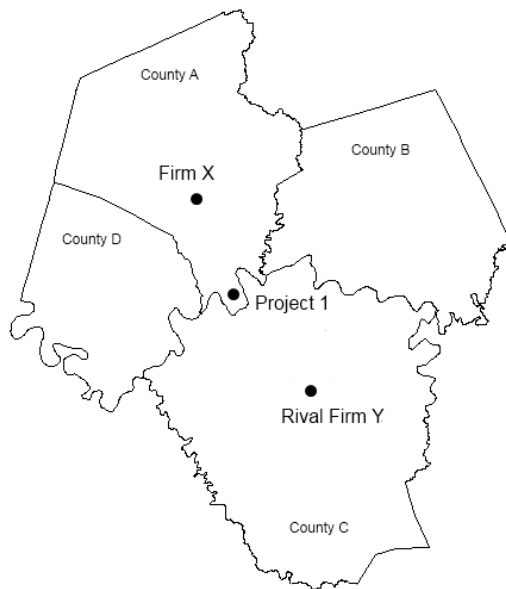


Figure 4.2: Project in adjacent county with rival asphalt plant

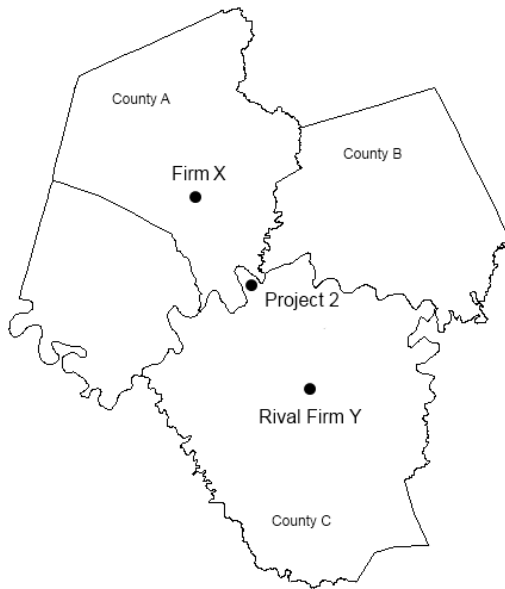


Figure 4.3: Project in same county with rival

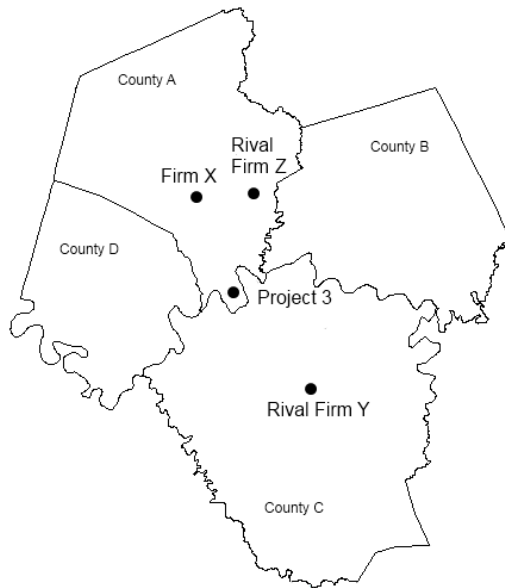


Figure 4.4: Project in adjacent county with no asphalt plant

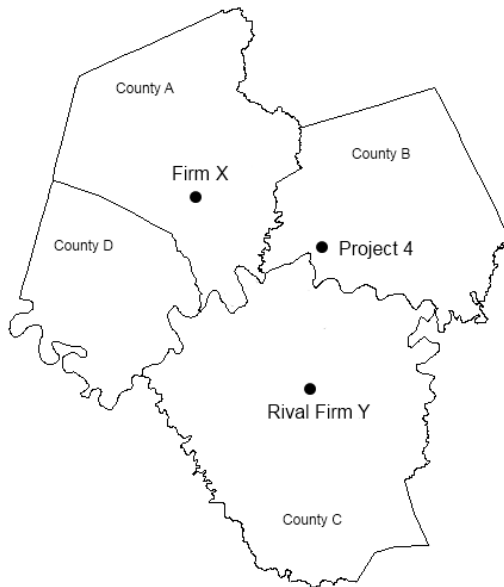


Figure 4.5: Four firms bidding behavior in Central Kentucky

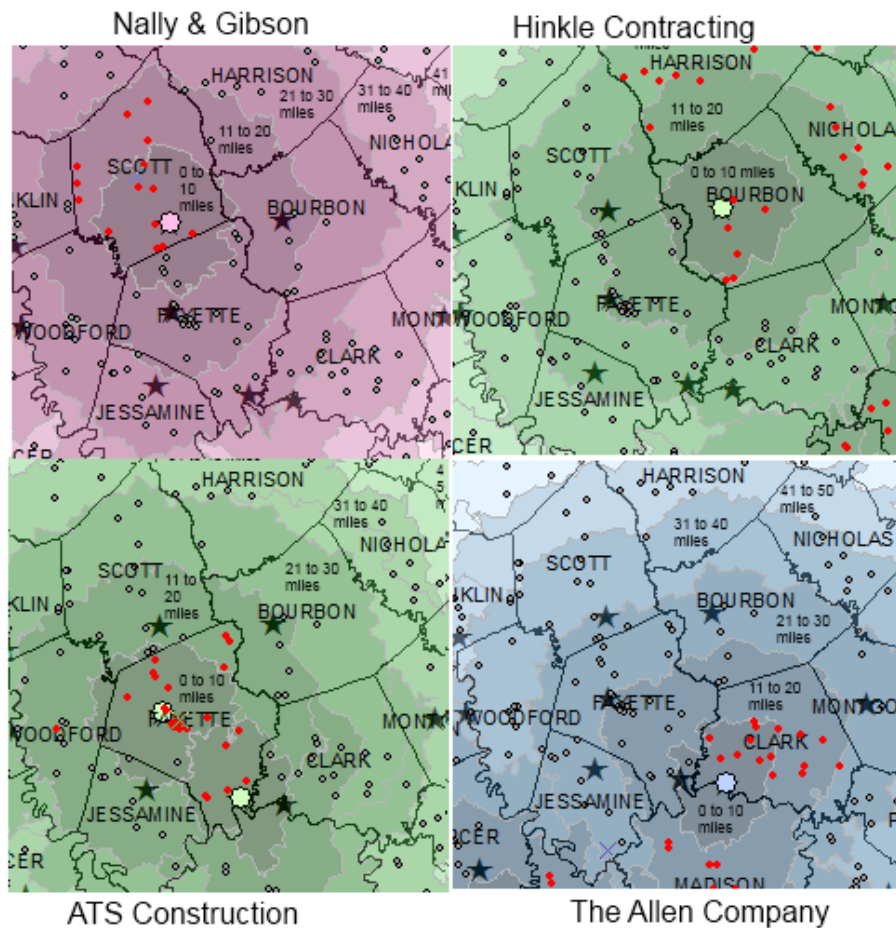


Figure 4.6: Asphalt Plant Locations in Kentucky

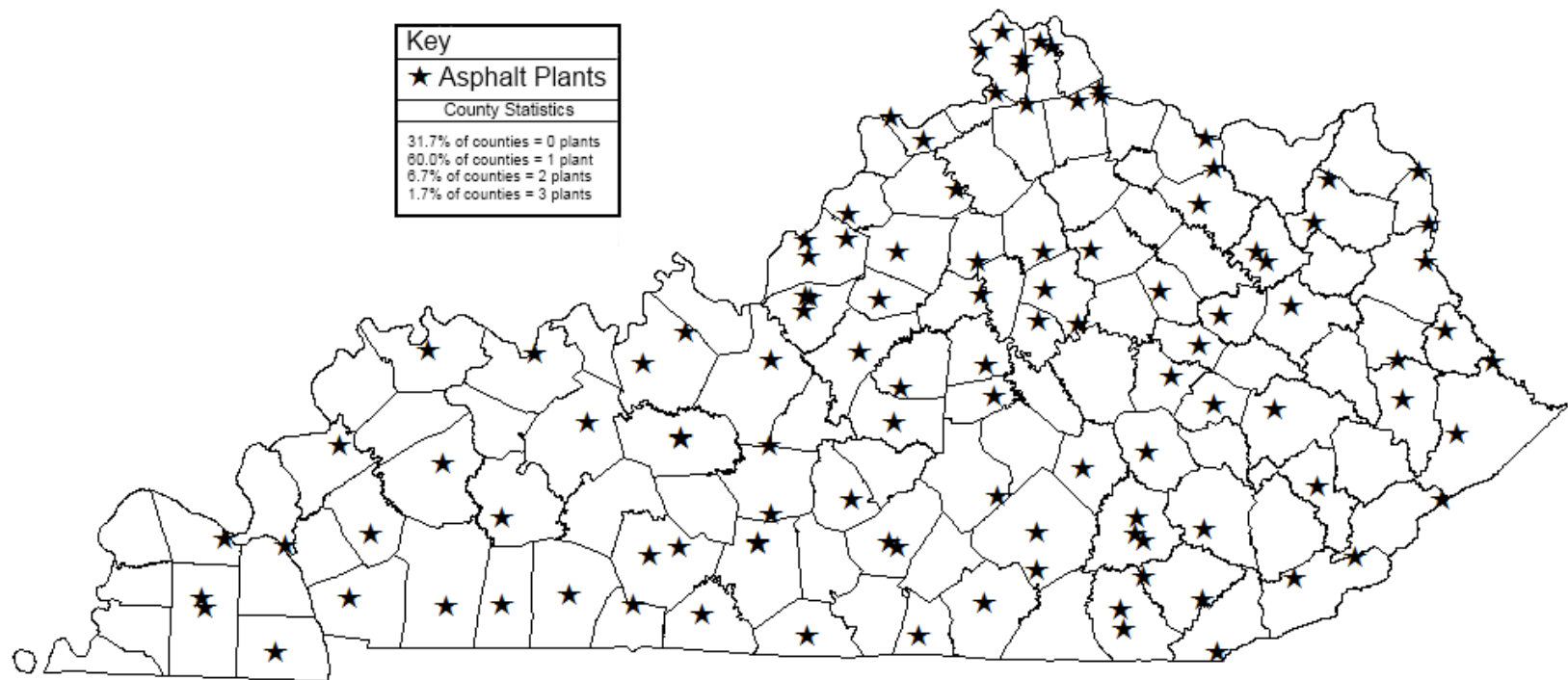
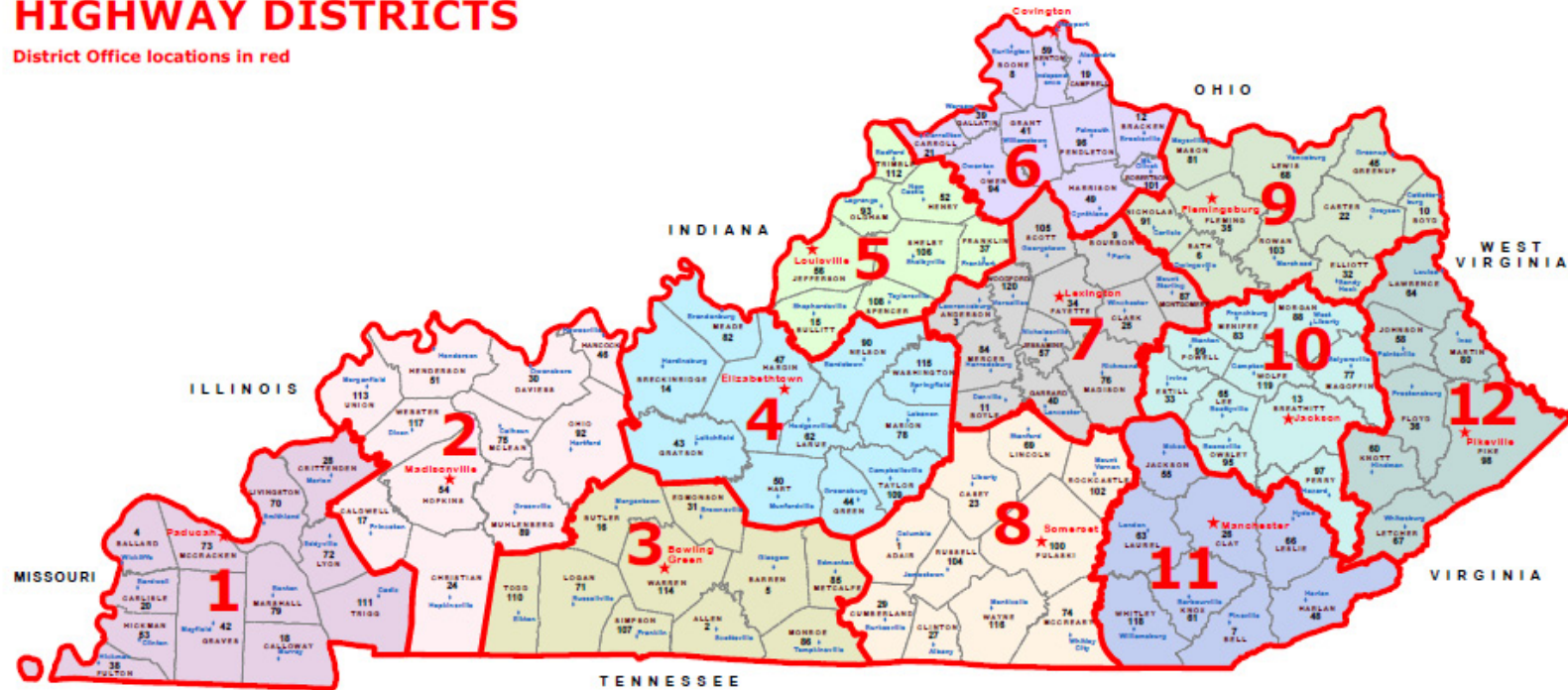


Figure 4.7: Kentucky Highway District Boundaries

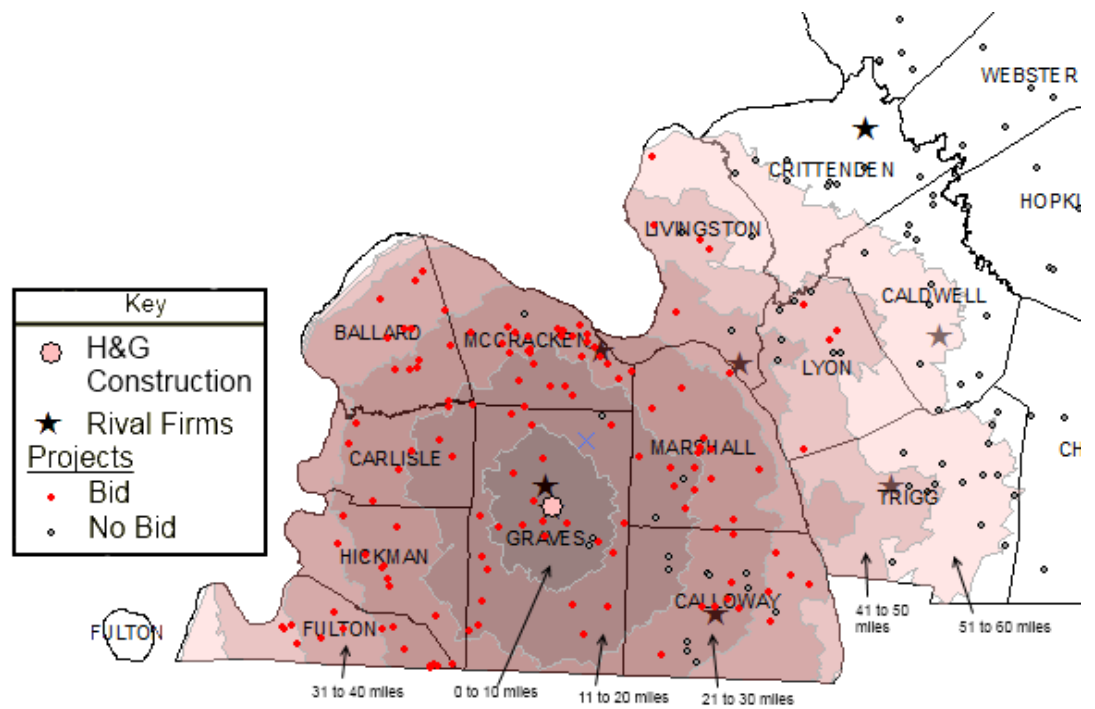
KENTUCKY TRANSPORTATION CABINET HIGHWAY DISTRICTS

District Office locations in red



Source: (Division of Planning, Kentucky Transportation Cabinet)

Figure 4.8: Service area – H&G Construction



5. CHAPTER 5: Empirical Model and Analysis

In order to determine whether firms are using county boundaries as focal points for tacit collusion, an individual bid function for each of the 31 firms in Kentucky was estimated. The firms located in Indiana were excluded from the regression due to lack of mapping information. Unlike the literature (see De Silva, et al. 2009) which combines all the data into one regression, each firm's bid function is estimated separately to see what factors influence the individual firm's bidding behavior. Since Kentucky varies in geography, each firm deals with different factors in their specific areas, and to control for these geographic factors each firm's individual bid functions were constructed. The purpose of the bid functions is to identify if firms are tacitly colluding. Specific firm and county variables were added in order to identify if firms were less likely to bid in a county where their competitor's bid or had asphalt plants. This allows me to identify which firms would avoid bidding against other firms and to flesh out the tit-for-tat strategy of the firms. This chapter provides details on the model that was used and the different specifications of the model. In the second half the chapter the methodology for determining if tacit collusion is occurring is discussed.

5.1 Model

Initially a probit model was used following the work of De Silva, et al. (2009). However, as outlined in the data chapter, firms tend to bid in their specific counties. When I ran the probits with fixed effects of counties it is subject to two problems, which both potentially bias the results in important ways. First, the fixed effects are estimated on small samples, and they cannot be differenced out in a non-linear model like probit. The fact that fixed effects are inconsistent creates bias for the whole model. The inconsistency arises from the lack of variance going to zero, as the county sample does not grow. Second, perfect classification, where a firm bids every time or never in a county, eliminates the county variables and the software drops the variables out of model. This affects some firms a lot, others very little. (see Appendix for the probit model for 11 firms. Note that some firms lose a lot of observations and others lose no variables.) This creates in effect selection bias because firms are not bidding in some counties, and they drop out of the sample rather than staying with some sort of coefficient. Neither of these problems can be eliminated in probit (or logit, or any other non-linear model). They constitute unfortunate but unavoidable problems in combining limited dependent variables and fixed effects.

A possible alternative is the linear probability model because it provides a linear approximation to whatever model is present and allows the fixed effects to stay regardless of the pattern of bidding. While the linear probability model is controversial because of its range (fitted values outside 0, 1), there is a tradeoff between this problem and the ones discussed in the previous paragraph.

Theoretically, the fixed effects in a probit model apply to the propensity score. If there is no bidding at all, the propensity score, which is abstract and unobserved, is negative infinity. That makes no sense—surely there is some probability of bidding—but the probit model is constructed in such a way that the result is required. The linear probability model only calculates that the probability of bidding is low, which is what most people would assume. The linear probability model represents the most logical way to represent firms that do not bid in a county.¹⁰⁷

The unit of observation for the linear probability model is a project within a firm's 60 mile service area. The dependent variable, y , is whether or not the firm bids on the project. If $y = 1$ then the firm bids on a specific project and if $y = 0$ then a firm did not bid on the project. The independent variables consist of dummy variables for distance (*Distance*).¹⁰⁸ These variables indicate if the firm bid on a project within specified 10-mile increments.¹⁰⁹ The reference category for this set of distance variables is the distance ring 0 to 10 miles. Breaking the distance up into 10 mile increments allows me to see where firms are less likely to bid based on distance and the range of each firms bidding. The next variable is *Jobs Under Contract*. This variable controls for the number of projects a firm has currently under contract from the Kentucky Transportation Cabinet when they bid on a project. The *Engineer's Estimate* was included to control for costs and size of the projects and other heterogeneity associated with the projects. Some firms only bid on smaller projects and do not bid on large resurfacing or rehabilitation

¹⁰⁷ J.S. Butler added invaluable insight into the reasons why the linear probability model is the best model for this analysis.

¹⁰⁸ In previous iterations of the bid functions I used distance and also distance squared. These results were similar to the results with the distance dummy variables. However, they did not provide the understanding of the point where distance started to matter to the firms. The continuous variable of distance was usually negative and significant.

¹⁰⁹ The rings are 0 to 10 miles (reference), 11 to 20 miles, 21 to 30 miles, 31 to 40 miles, 41 to 50 miles, and 51 to 60 miles.

projects. *Potential Competitors* is a variable that indicates how many competitor firms have the project within their 60 mile service area.¹¹⁰ The *Bid Proposal* variables are a set of dummy variables that indicate how many competitor firms have purchased bid proposals.¹¹¹ The reference category for this set of variables is when no competitor firms have purchased a bid proposal. This first bid function is found in equation (A).

$$(A) \quad y = \beta_0 + \beta_1 (\text{Distance}) + \beta_2 (\text{Jobs Under Contract}) + \beta_3 (\text{Engineer's Estimate}) + \beta_4 (\text{Potential Competitors}) + \beta_5 (\text{Bid Proposals}) + \varepsilon$$

The distance, the number of jobs under contract, and the engineer's estimate are used to control for costs of the project which impacts whether or not a firm bids on a project. Distance from the firm to the project is expected to negatively affect the probability of bidding. De Silva, et al. (2009) finds a significant negative relationship between distance and the probability of bidding. KYTC officials have also stated to me that as a project is farther from the firm's asphalt plant the firm is less likely to bid on the project, because as a project gets farther away the transportation cost of completing the project increases. If the distance variables are not significant then the firm is treating projects within 10 miles of their plants the same as project 60 miles from their plants in terms of whether or not they bid on the project. Distance would not be a major factor in their bidding. If distance impacts whether or not a firm bids on a project the variables will be negative and significant. The results for this set of dummy variables also shows where distance starts to decrease the probability of a firm bidding on a project.

Previous research indicates (see Jofre-Bonet and Pesendorfer 2003; De Silva, et. al. 2009) that the current level of contracted projects (capacity constraints) decreases the probability of bidding. In an interview with me, KYTC officials do not see capacity constraints as a concern on whether or not a firm bids on a project. This variable is included in this model to

¹¹⁰ In an earlier iteration of the service areas, the service areas were confined to just 40 miles for all but two firms who had 50 mile service areas. Likewise the *Potential Competitor* variables were at the same distances. When the service areas were expanded to 60 miles, I ran an analysis for all firms with the same 40/50 mile services areas for the *Potential Competitor* variable. I then expanded the *Potential Competitor* variable to 60 miles. I did not see any major differences between the two analyses.

¹¹¹ In order to bid on a project a firm must purchase a bid proposal. These bid proposals cost \$10 and the bid proposal list is published the Friday before the actual bidding takes place. Before 2008, firms could refuse to have their name published on the bid proposal list. It became mandatory for firms to have their names on the list during 2008.

control for capacity constraints. If capacity constraints do matter the variables will be negative and significant. The engineer's estimate is included to control for contract heterogeneity including the size and scope of the project (Han Hong and Matthew Shum, 2002).

The variables for potential competitors and the number of bid proposals purchased by competitor firms controls for the behavior of rival firms. If a firm tries to avoid bidding against competitors it could show up in these variables. The *Potential Competitor* variable indicates how many competitor 60 mile service areas a project is in. If this variable is negative and significant then this indicates they are less likely to bid as the more potential competitor's increases. If it is positive and significant then, it could indicate they are a competitive firm that actively bids on lots of projects. The set of bid proposal dummy variables gives an indication of whether or not firms react to competitors purchasing bid proposals. If a competitor purchasing a bid proposal deters them from bidding on a project then these variables will be negative and significant. Equation A is run for each of the firms.

The purpose of running model (A) is to see what factors influence bidding if I assume no tacit collusion is taking place. If firms are not colluding, then the cost and competitive variables should be what is driving a firm's decision to bid on a project. The major factors that drive the bidding may vary from firm to firm, but distance should significantly influence whether a firm bids on a project. If tacit collusion is not occurring, then the addition of the county variables in subsequent models should make little difference in the results between the models. In the next specification, the county variables are added to see how the location of projects in counties impacts firms' bidding behavior (see equation B).

$$(B) \quad y = \beta_0 + \beta_1(\text{Distance}) + \beta_2(\text{Jobs Under Contract}) + \beta_3(\text{Engineer's Estimate}) + \\ + \beta_4(\text{Potential Competitors}) + \beta_5(\text{Bid Proposals}) + \beta_6(\text{County : All}) + \varepsilon$$

The *County: All* variable is a set of dummy variables. *Project in same county-no rival* is the reference category for the set of county variables and is excluded from the regression. This variable indicates that a project is located in a county where the firm has an asphalt plant. No other rival firms have asphalt plants in those counties. At times *Project in same county-rival* is the reference category since some firms only have asphalt plants in counties where a rival firm also has an asphalt plant. An adjacent county is a county that is next to a county where a firm has an asphalt plant. These two counties do not have to be bordering each other. *Project in*

adjacent county-no rival indicates that a project is in an adjacent county, and there are no asphalt plants in that county. *Project in adjacent county-rival* indicates that a project is in an adjacent county and a rival firm has an asphalt plant in the county. If firms are using the county boundaries to coordinate bids, these variables will give an indication of this behavior. If firms are less likely to bid on projects in counties where rival firms have asphalt plants then the *Project in adjacent county-rival* variable would be negative and significant, all else constant. This means that with all other variables controlled for a firm is less likely to bid on a project simply because it is in a county where a rival has an asphalt plant. This could be an indication of coordination of bidding between firms. In order to identify coordination of bidding between firms variables the *Project in adjacent county-rival* variable was broken out into specific rival firms in specification (C).

$$(C) \quad y = \beta_0 + \beta_1 (\text{Distance}) + \beta_2 (\text{Jobs Under Contract}) + \beta_3 (\text{Engineer's Estimate}) + \\ + \beta_4 (\text{Potential Competitors}) + \beta_5 (\text{Bid Proposals}) + \beta_6 (\text{County : W/O Rival Firms}) + \\ + \beta_7 (\text{County : Rival Firms}) + \varepsilon$$

For specification (C) and (D), the *Project in adjacent county-rival* and *Project in adjacent county-no rival* were identified for specific firms and counties, respectively. Specification (C) has a variable that identifies specific firms that are located in an adjacent county. This allows me to see specific rivals a firm is or potentially could bid against. For example, in Rogers Group specification (C) the *Project in adjacent county-rival* is converted into *Project in adjacent county-Scotty's Contracting*. The variable indicates how Rogers Group responds to the presence of Scotty's Contracting's asphalt plant in an adjacent county. If it is negative and significant then Rogers Group avoids bidding on projects where Scotty's Contracting has an asphalt plant. This variable is created for every firm. The *County: Rival Firms* variable is a vector of variables that contains all of these county variables with specific firms. The coefficients of these specific firm variables help me understand how firms react to specific firms. How this variable helps identify tacit collusion is discussed in section 5.2.

$$(D) \quad y = \beta_0 + \beta_1 (\text{Distance}) + \beta_2 (\text{Jobs Under Contract}) + \beta_3 (\text{Engineer's Estimate}) + \\ + \beta_4 (\text{Potential Competitors}) + \beta_5 (\text{Bid Proposals}) + \beta_6 (\text{County : W/O No Rival}) + \\ + \beta_7 (\text{County :No Rival Firm}) + \varepsilon$$

In specification (D), the generic *Project in adjacent county-no rival* is changed to indicate specific counties. This allows a look at how firms are reacting to a project being in a county where firms bid but do not have an asphalt plant. For example, Clark County in central Kentucky has no asphalt plants. This county is specified in model (D) as *Project in Clark County* in each individual firm bid function. If the variable is negative and significant for a firm, then it indicates that they are less likely to bid in Clark County. A variable is created for every county where there is no asphalt plant. The *County: No Rival Firm* variable in specification (D) is a vector of variables indicating adjacent counties where no firms have asphalt plants. How this variable helps identify tacit collusion is discussed in section 5.2.

5.2 Identifying tacit collusion between firms

The individual firm bid functions allow me to determine whether tacit collusion is occurring. Having controlled for distance and the other cost and competitor factors that influence whether or not a firm bids on a project, specifications (C) and (D) are used to identify the specific firm pairs that are tacitly colluding. This analysis is performed on a county-by-county basis.

The first step in identifying if firms are using county boundaries to coordinate their bidding is to identify the firms that can reasonably bid on projects in a county. If a firm has all of the projects in a county within their 60 mile service area, then the firm is considered a potential competitor for the county. The reason for this is that a county may have many firms that have a portion of their 60 mile service area that overlaps a small portion of the county. These projects could end up being 50 to 60 miles from an asphalt plant and the other projects not in the service area could be even further. This is simply to restrict the number of firms that is included in the analysis and identify the firms that can compete on a county basis.

Once the potential competitors are identified, the next step in the empirical analysis is to identify the competitors that are tacitly colluding. This is done by looking at the results in specification (C) and (D). If firms are engaging in tacit collusion, they are more than likely employing a tit-for-tat strategy where firms avoid bidding against each other which results in only one bidder on a project. If a firm refuses to bid in a county where the other firm bids and/or has an asphalt plant, then in a tit-for-tat strategy the rival firm would in turn refuse to bid against the firm. The firms react to each other's bidding behavior by not bidding. The county

boundaries are used by the firms to coordinate where each firm should bid. If a firm cheats and bids in a rival's county, the rival firm can react by retaliating against the firm by bidding against the other firm in their territory. This would enable the firms to enforce this tacit collusion as they bid against each other month after month. The county boundary is the focal point which allows this strategy and help firms know if a rival is cheating. With this in mind, to identify tacit collusion it is important to identify that both firms are refusing to bid against each other.

There is evidence of tacit collusion if both firms are less likely to bid against each other where the firms have asphalt plants or bid regularly on projects. In specification (C) the *Project in adjacent county-rival* variable was broken out and the "rival" was specified as specific firms as described in section 5.1. If the coefficient is negative and significant this indicates that a firm is less likely to bid on a project in a county where the specific rival has an asphalt plant. If the rival firm in turn exhibits this behavior, then there is evidence that the firms avoid bidding against each other and are tacitly colluding. This is after distance and the other factors are controlled.

For example, H.G. Mays does not bid on a project in Anderson County where Mago Construction has an asphalt plant, and Mago Construction does not bid on a project in Franklin County where H.G. Mays has an asphalt plant, holding all else constant (see Figure 5.1). It is clear from the map that H.G. Mays and Mago Construction could be engaging in tacit collusion. The regressions results, which are detailed in Chapter 6, are negative and significant for both firms (i.e. *Project in Adjacent County-H.G. Mays* and *Project in Adjacent County-Mago Construction*). This indicates that H.G. Mays is less likely to bid in a county where Mago Construction has an asphalt plant, and Mago Construction is less likely to bid in a county where H.G. Mays has an asphalt plant after controlling for the other factors. The regression results confirm what the map indicates, and there is evidence of tacit collusion. This is evidence of a tit-for-tat strategy which is characterized by "If you do not bid in my county, I will not bid in your county."

In order to find no evidence of tacit collusion, only one of the firms would need to have a result that is not significant. If H.G. Mays is less likely to bid on a project in a Mago Construction county, but Mago Construction's *Project in adjacent county-H.G. Mays* coefficient is not significant then there is no evidence of tacit collusion between these two firms. There would be no evidence that both firms are engaging in the coordination of bids. It has to be a

refusal to bid on the part of both firms in order to establish that the firms are coordinating their bids.

This analysis can be extended to counties where no firms have an asphalt plant. In specification (D) a variable was constructed for each county where there were no asphalt plants as described in section 5.1. These variables were included in the regression to see if firms treat these adjacent counties similar to counties where they have asphalt plants, or if the firms are less likely to bid in these adjacent counties because a rival firm is the primary bidder in the county. For example, in Clark County The Allen Company is the only firm that bids on projects in that county (see Figure 5.2). If firms are colluding with The Allen Company on projects in Clark County, then those firms would be less likely to bid on projects in Clark County and the coefficient on this variable in specification (D) would be negative and significant. The Allen Company would have to be less likely to bid on projects in counties where these rivals have their plants or are the primary bidder for there to be evidence of tacit collusion. If Hinkle Contracting is less likely to bid on projects in Clark County and The Allen Company is less likely to bid on projects where Hinkle Contracting has an asphalt plant, then there is evidence these two firms are tacitly colluding and coordinating bids on projects in Clark County. The regression results in Chapter 6 confirm this behavior, and Figure 5.2 illustrates this behavior. It is important to remember that in the regression analysis the other factors are held constant. This same analysis is done for every potential competitor for projects in the counties where there are no asphalt plants.

5.3 Identifying financial impact of tacit collusion

In both counties with asphalt plants and without asphalt plants, the behavior that I am trying to detect is whether or not firms are coordinating their refusal to bid. The underlying purpose for this behavior is that by cooperatively refusing to bid in each other's territories they can increase bid levels above cost and increase their profit. One reason firms engage in collusion is to behave like a monopolist. Another part of the analysis in the results section will be to determine how much tacit collusion increases the bid levels. In counties where firms are competitive, bid levels should be lower than counties where there is only one firm bidding on a project if the single-bidder is behaving like a monopolist. The engineer's estimate is the cost estimate the Kentucky Transportation Cabinet puts together for each project. This engineer's estimate allows me to see how much the winning bid is above or below the engineer's estimate.

By converting the winning bid to a percentage over or under the engineer's estimate, projects can be compared to each other regardless of the monetary size of the project. For example, in District 7, the single-bid contracts or winning bids average 2.49 percent above the engineer's estimate. When two or more bidders bid on a project, this average for winning bids falls to 22.18 percent below the engineer's estimate. This is a difference of 24.67 percentage points. I am interested in this difference between the percentage over or under the engineer's estimate for the single-bid contracts versus the multi-bid contracts. In order to calculate how much collusion increases bid levels, this percentage difference between contracted value of the single-bid projects and the multi-bid projects was then multiplied by the actual contracted value of the single-bid contracts in the county to get a sense of how much tacit collusion increased bids. This was done on a county-by-county basis.

For example, in Bourbon County there is evidence of tacit collusion between Hinkle Contracting and The Allen Company and other firms. These rival firms do not bid on projects in Bourbon County which results in only one firm bidding and winning all the projects. The contracted value of all seven of the projects is \$2,022,283.40. These seven projects average 0.97 percent above the engineer's estimate. This is then compared to the multi-bid level for the winning bids in District 7, which averages 22.18 percent below the engineer's estimate.¹¹² The difference between the single-bid contracts for Bourbon County and the multi-bid level for District 7 is 23.15 percent. This means that winning bids in Bourbon County average 23.15 percent above the competitive level for District 7 or the bids are \$468,158.61 above the competitive level.¹¹³ This is the impact of tacit collusion on bid levels, and this analysis is repeated in all of the counties in Kentucky where tacit collusion is identified. If there is a county with no tacit collusion then this analysis is not done.

5.4 Conclusion

The purpose of this analysis is to see if firms are tacitly colluding with each other. Since these firms bid against each other month after month, they have to sustain this bidding

¹¹² The single-bid contracts were compared to the multi-bid contracts of the district the counties are in. This was to control for heterogeneity between the districts. Each district has different firms and other factors that influence the average of the multi-bid projects. There is only one case where the single-bid contracts were compared to the Kentucky multi-bid contract average. This was in District 10.

¹¹³ $\$2,022,283.40 * 0.2315 = \$468,158.61$

behavior by using a focal point to coordinate the bids. This allows the firms to engage in a tit-for-tat strategy where one firm refuses to bid in a county where the other firm bids and/or has an asphalt plant, and in turn the other firm reacts by not bidding in the firm's county. To identify this behavior, bid functions were constructed for each firm which included variables which identify if a firm has an asphalt plant in a county. If both firms are tacitly colluding then they are less likely to bid in each other's territories. This same analysis extends to counties without asphalt plants. The overarching purpose of the analysis is to identify which firms are engaging in this tit-for-tat strategy and then identify how much this tacit collusion increases bid levels above the competitive level. This analysis is discussed in detail in the results chapter.

Figure 5.1: H.G. Mays and Mago Construction in Central Kentucky

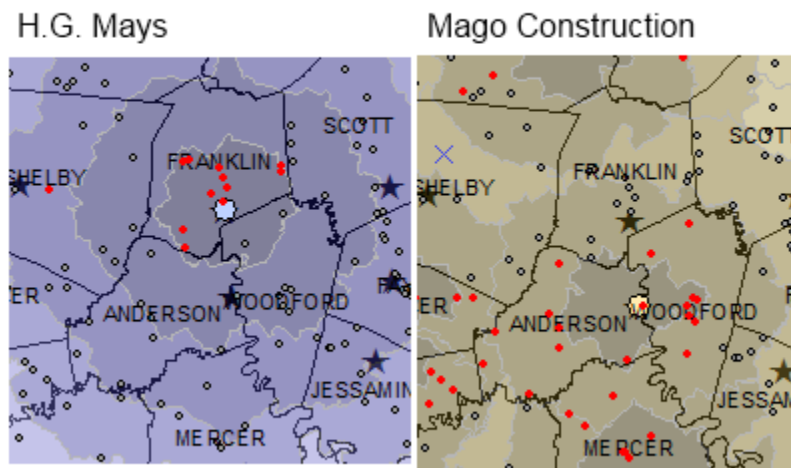
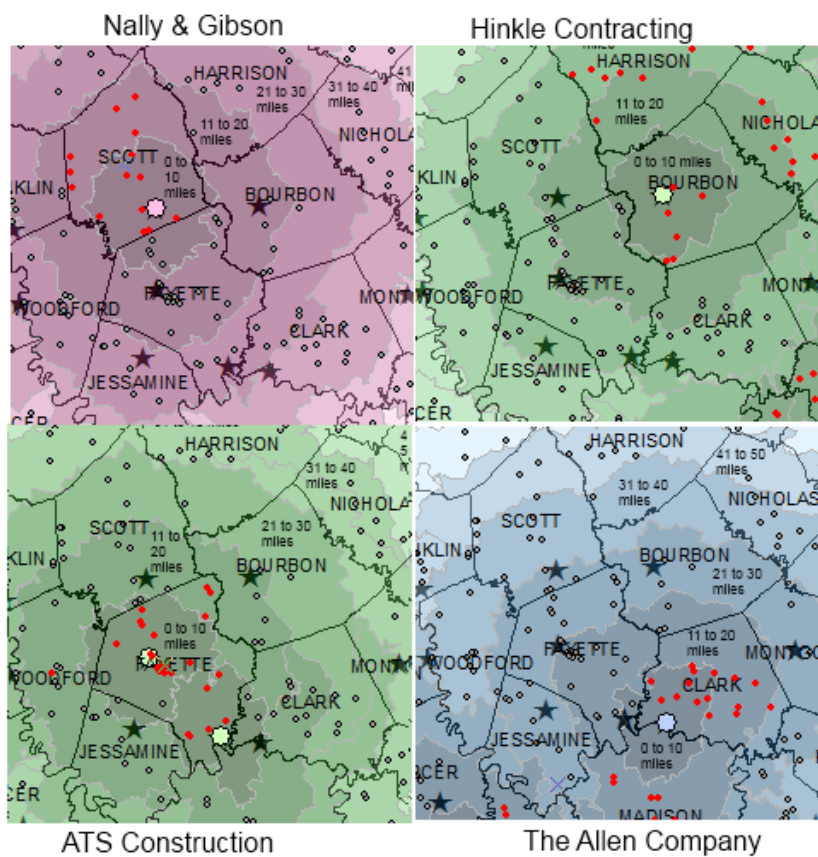


Figure 5.2: Clark County and potential firms



6. CHAPTER 6: Results

6.1 Results

The question of interest of this dissertation is whether or not the high level of single-bid contracts is an indication of the market working efficiently or a result of tacit collusion. The results of the individual firm analysis and county-by-county analysis are found in the sections for each district and will be summarized in this section.

As discussed in an earlier chapter, tacit collusion is more likely if there is a focal point for firms to coordinate bids. My analysis of bidding on asphalt paving projects in Kentucky has found that firms use county boundaries to coordinate bidding. In general, this results in firms not bidding across the county boundaries in counties where a rival firm has an asphalt plant or where a rival firm bids on projects if there is no asphalt plant in the county. The purpose of coordinating bids is to increase bid levels and behave like a monopolist which results in more revenues to the firm. The result is a high number of single-bid contracts with only one firm bidding because the other firms refuse to bid. On average these bids are 2.22 percent above the engineer's estimate. When there is a competitor this average drops to 14.28 percent below the engineer's estimate. However, firms do not always stick to their territories. There is a continuum of competitive situations found in the counties of Kentucky. There are counties that are competitive with no evidence of tacit collusion such as Meade County. On the other end of the continuum there are counties such as Pike County where Mountain Enterprises is the only viable bidder. In between these two extremes, are counties where evidence of tacit collusion is found, but it has no impact on bid levels. This non-bidding by firms is probably a result of the competitive atmosphere of the county. Jefferson County is an example of where this occurs. There is also a situation where potential competitors refrain from bidding on projects and there is only one bidder on projects in the county and this leads to higher bid levels. Clark County is an example where this occurs. There is clear evidence of firms using counties boundaries to coordinate bids and engage in a tit-for-tat strategy. In other words, "If you don't bid in my county, I won't bid in your county." Results of each district will be summarized in the next paragraphs.

The primary result of the tacit collusion is a high number of single-bid contracts which occurs in all the districts. The engineer's estimate is used as a benchmark to analyze how much a bid is over or under it. When the percentage over or under the engineer's estimate is calculated

for single-bid contracts and multi-bid contracts, single-bid contracts are higher than multi-bid contracts. This is the expected result since competition usually drives down bid levels. What is important is the distance between the multi-bid contract percentage and the single-bid contract percentage. In Kentucky multi-bid asphalt projects average 14.28 percent below the engineer's estimate. Single-bid contracts average 2.22 percent above the engineer's estimate. The question of interest is how much of this difference of 16.50 percent results from tacit collusion. This is calculated on a county-by-county basis in each section and the results indicate that contracted bid levels for single-bid contracts are \$70,595,466.09 higher than the competitive level due to tacit collusion. More of these results are discussed later on in this section.

The next few paragraphs will summarize the results that are in sections 6.2 through 6.13. First, I will look at the counties that are competitive and some of the trends that occur in these counties. Next, I discuss the counties where there are many firms that could bid on projects but do not because of tacit collusion. Then, I discuss the counties where only one firm can bid on projects. Finally, I summarize the firms that tacitly collude with each other and the financial impact it has on bids.

COMPETITIVE COUNTIES

There are eight counties in Kentucky where the firms that can bid on the projects do bid on the projects. If firms are not bidding on the projects it is because of some other factor and not tacit collusion. An example of the competitive counties is Ballard, Carlisle, Fulton and Hickman in District 1. Jim Smith Contracting and H&G Construction actively bid against each other in these counties. The contracted value of the bids in these counties is near the competitive level for District 1 of 6.41 percent below the engineer's estimate. These counties are an example of counties where there is just competition and no tacit collusion is detected. Meade County in District 4 is another one of these counties. Every project has more than one bidder and the contracted value of the projects average 18.37 percent below the engineer's estimate. Firms such as Mago Construction and Scotty's Contracting, who normally avoid bidding against each other, actively bid on projects in Meade County. There is no evidence of tacit collusion in this county and bid levels reflect this competition.

Firms such as Kay & Kay Contracting and H&G Construction help some counties be competitive. Kay & Kay Contracting started bidding regularly on asphalt paving projects in 2006,

halfway through the sample. They regularly bid on projects in counties where Elmo Greer & Sons has their asphalt plants. The impact of them bidding regularly has dropped the bid levels significantly. When Elmo Greer & Sons was the lone bidder, the bids averaged 2.81 percent above the engineer's estimate. When Kay & Kay Contracting started bidding regularly it dropped the bid levels to an average of 20.96 percent below the engineer's estimate. The common characteristics of firms that actively bid in and do not engage in tacit collusion is they are usually firms with one asphalt plant and they have a rival firm they target in their bidding.

Another subset of competitive counties is those where there are multiple bidders, but there is evidence of tacit collusion in the county. In this case two or more firms are bidding on projects in a county. However, another firm avoids bidding on projects in the county because they do not regularly bid on projects in counties where those firms have their asphalt plants or bid. They could also avoid bidding in these counties because competition is so fierce, and if they did bid and won the project they could lose money. The fact that these firms avoid bidding in these counties has little or no impact on bid levels. An example is Oldham County where every project has more than one bidder, and where there is evidence that Commercial Pavers is less likely to bid on projects in Oldham County and in turn Ohio Valley Asphalt avoids bidding on projects in Jefferson County. The impact on bids is negligible because of the other firms bidding on the projects. Oldham County would be considered a county where evidence of tacit collusion was found, but there is no impact on bid levels. Finding evidence of tacit collusion in competitive counties happens in 13 out of the 120 counties. However, there is no impact on bid levels.

Another interesting situation is Powell County where Hinkle Contracting and The Walker Company "competitively" bid on projects. Hinkle Contracting has an asphalt plant in Powell County, but The Walker Company bids on projects in that county. What is remarkable is that even those these firms both bid on projects it does not drive down the bid levels. In fact the multiple bid contracts average higher above the engineer's estimate than the single-bid contracts. I could find no reasons why this is occurring. However, the behavior does not match what is occurring in the other parts of Kentucky. This appears to be a similar to the collusive result.

COLLUSIVE COUNTIES

A common occurrence in the counties in Kentucky is that some projects in a county have multiple bidders and then some projects only have one bidder. The potential competitor firms in these counties were analyzed and in some cases tacit collusion was detected and in other cases it was not. There are specific firms that seldom bid in counties where a rival firm has an asphalt plant. For example, Hinkle Contracting seldom bids on projects where Mountain Enterprises has an asphalt plant. The results indicate that it is because of tacit collusion and these firms avoid bidding against each other using county boundaries as a focal point to determine where they should or should not bid. This is true in Lawrence County where Mountain Enterprises has an asphalt plant, and Hinkle Contracting does not bid on any projects even though all of them are within their 60 mile service area. In some cases Blacktop Industries bids on some of the projects but there is no evidence they are tacitly colluding with Mountain Enterprises. There is evidence of tacit collusion between Hinkle Contracting and Mountain Enterprises not only in Lawrence County but in every other county where these firms have asphalt plants or bid with the exception of Elliott County. The result is by not bidding against each other they are able to increase bids above the competitive level and toward the monopoly level which results in more profits for the respective firms.

In some cases there are not just two firms that are tacitly colluding but upwards of nine firms. This may seem surprising but it actually illustrates the power of the county boundaries as a mechanism to coordinate bidding. Since county boundaries are so well known it is easy for the firms to avoid bidding where another firm has their asphalt plants or bids. This can lead many firms to avoid bidding in a county when they reasonably could bid on all of the projects. In turn the firm in that county does not bid on projects in a county where that firm has an asphalt plant. For example, in Anderson County Mago Construction has an asphalt plant. Other firms that are potential competitors and have all of the projects in Anderson County in their service area include The Allen Company, ATS Construction, Commercial Pavers, H.G. Mays, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Nally & Haydon Surfacing, Nally & Gibson Georgetown, and Shelbyville Asphalt. These firms do not bid on one project in Anderson County. The bid functions and maps for these firms were analyzed and they are less likely to bid on projects where Mago Construction has an asphalt plant including Anderson County after controlling for distance and other factors. In turn Mago Construction is less likely to bid on

projects where these firms have their asphalt plants. One example is that Anderson County borders Franklin County where H.G. Mays and Washington County where Nally & Haydon Surfacing has an asphalt plant. These firms do not bid on projects in each other's counties and this shows up in the regression results.

At times firms cheat and do not stick to their territory in bidding. One of these firms is Scotty's Contracting. There is evidence of tacit collusion between Scotty's Contracting and Mago Construction in District 4. However, Scotty's Contracting bids on projects in Breckinridge County where Mago Construction has an asphalt plant. There is no consistent pattern to when Scotty's Contracting bids in Breckinridge County and they only bid on a few projects. Yet Mago Construction still does not bid against Scotty's Contracting in counties where they have an asphalt plant such as Hardin County. Scotty's Contracting and Mago Construction also bid against each other on projects in Meade County which is a very competitive county. On the flip side, Scotty's Contracting does not bid on any projects in Nelson County where Mago Construction has an asphalt plant. The regression results indicate that after all the other factors are controlled, these two firms are tacitly colluding; however it is not perfect collusion. It is possible Mago Construction does retaliate to make sure Scotty's Contracting sticks to their counties but this was not detected.

In order to maintain the collusive arrangements without communicating over months and years there must be a means of enforcing it. Firms can resort to retaliation when a rival firm cheats. There is evidence of tacit collusion between Scotty's Contracting and Glass Paving in District 3 and 4. On May 26, 2006, Scotty's Contracting bid on a project in Barren County where Glass Paving had been the primary bidder. This did not trigger retaliation from Glass Paving. However, when Scotty's Contracting bid on a project in Hart County on July 21, 2006 where Glass Paving has one of the asphalt plants and is the exclusive bidder Glass Paving retaliated. At the next bid on August 11, 2006, Glass Paving retaliated and bid on projects in Edmonson, Metcalfe and Monroe Counties where Scotty's Contracting is the primary bidder. The retaliation was immediate and swift. They bid on projects in counties they normally do not bid on. After this retaliation, the bidding went back to "normal" and Scotty's Contracting did not bid in Glass Paving's counties and Glass Paving did not bid in Scotty's Contracting counties through the rest of 2006 and 2007.

MONOPOLY COUNTIES

In a five cases there are counties where only one bidder can reasonably bid on projects. This includes Floyd, Letcher, Martin, and Pike County in Eastern Kentucky. Mountain Enterprises is the only firm that can reasonably bid on all the projects in these counties. Hinkle Contracting can bid on some of the projects in Floyd County but not all of them. In Letcher and Pike Counties no other firm can viably bid on the projects. Blacktop Industries can bid on projects in Martin County, but they do not so it essentially leaves only Mountain Enterprises to bid on projects. Consequently, there are only single-bid contracts and the bid levels are well above the competitive level for District 12 and for Kentucky. Firms that create monopoly-type situations through tacit collusion seek to increase the bids to monopoly levels. At times the firms are able to achieve this and at other times they are not.

FIRMS THAT TACITLY COLLUDE

The full analysis of every county is contained in the next 12 sections. I have touched upon some of the different competitive and anticompetitive environments that exist in Kentucky. Table 6.3 shows the 25 firms that are tacitly colluding and the firms that are tacitly colluding with them. There are six firms where there is no evidence of tacit collusion occurring including Blacktop Industries, Bluegrass Paving, Flynn Brothers, H&G Construction, Kay & Kay Contracting, and Qualified Paving. All of these firms only have one asphalt plant and bid aggressively against rival firms. Their bidding behavior or lack of bidding is explained by another factor such as distance from plant to project. Table 6.3 indicates the counties where both firms are potential competitors, which mean both firms have all of the projects in the county in their 60 mile service area. The second column of numbers indicates the number of counties where evidence of tacit collusion was found between the two firms. More specific detail is provided in each individual section.

For example, there is evidence that Mago Construction colludes with 18 firms. The way this is accomplished is that they stick to bidding in the counties where they have asphalt plants. They seldom bid in adjacent counties where a rival firm has an asphalt plant. They bid in adjacent counties such as Meade County where there are no rival firms with asphalt plants. In this situation they can face some competition. One characteristic of Kentucky is that counties where no firms have asphalt plants can be a place where multiple firms bid on projects. In Table

6.3, it shows that Mago Construction and The Allen Company are potential competitors in 11 counties, and there is evidence of tacit collusion in all 11 counties between these firms. Notice that Mago Construction and Yager Materials are potential competitors in three counties, however there is only evidence of tacit collusion in two of those counties. This is because Yager Materials and Mago Construction compete against each other on projects in Meade County. This analysis is continued for all firms in all counties and is summarized the aforementioned table.

FINANCIAL IMPACT OF TACIT COLLUSION

In calculating the financial impact that tacit collusion has on bid levels, it is important to remember that the tacit collusion is characterized by firms refusing to bid against their rivals and the rivals return the favor in a tit-for-tat strategy. This is how the tacit collusion is characterized throughout all districts in Kentucky. For all districts there are 107 out 120 counties where there is evidence of tacit collusion, and in 94 of those counties this tacit collusion leads to increases in bid levels. The next step in the analysis is to estimate the extent to which this refusal to bid on projects results in increased bids. The purpose of collusion is to increase bid levels so firms can make more revenue. By coordinating bids with each other the firms are able to increase bid levels above the competitive level. The engineer's estimate is used in the analysis to normalize the bids by showing how much a bid is over or under the engineer's estimate. An average for multi-bid projects and single-bid projects in Table 6.2 shows that there is a significant difference between the competitive average and the single-bid average. Thus by tacitly colluding firms are able to increase bid levels.

As each county was analyzed and where tacit collusion was detected, the monetary value of the tacit collusion was calculated. It was determined by calculating the difference between the competitive level of bids for the county and the level of bids on the single-bid contracts. Only where there was evidence of tacit collusion was this analysis performed. The analysis found that tacit collusion results in bids that are \$70.6 million above the competitive level. This is the amount that firms are able to increase bid levels above the competitive level for the district. There are some circumstances where only one firm can reasonably bid on all projects in a county and those figures are not included in this number. In more competitive counties, the bid levels are at or below the competitive level for the district. In this case, the ability of firms to tacitly collude has no impact on bid levels. This means that if firms were not

engaging in tacit collusion, the bids would be around \$70.6 million less than their current level. This is over a three period and represents tax revenue that could have been used to fund other areas of government or returned to the tax payers.

The rest of the results chapter will detail the bidding of the firms in each district and each county. Individual firm bid functions are discussed and their bidding behavior is analyzed. In certain counties there are other small firms that are mentioned as bidding on projects including Certified Construction of Kentucky and Burton Paving to name a few. These firms were not included in the analysis due to their limited bidding and in some cases lack of information about the firm. At the end of each district are tables and maps for each firm. Just as a reminder for the results section, a potential competitor is a firm that can bid on all of the projects in a county. The reason to make this distinction is that some projects have multiple locations in a county. If a firm cannot service all of the locations of the project then they are not going to bid on it. For this reason, if a firm's service area did not encompass all of the projects locations in a county they were not considered a potential competitor. Some firms may be able to service a few projects in a county and a result may appear in their regressions. These firms may have been excluded from the discussion of whether or not tacit collusion is occurring because they do not service all of the projects in a county.

Table 6.1: Summary of Bidding for All 12 Districts- All bids

All Projects				
DISTRICT	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Avg. Number of Bidders
DISTRICT 1	104	\$ 42,021,541.51	-4.27	1.74
DISTRICT 2	106	\$102,776,730.11	-0.43	1.33
DISTRICT 3	73	\$ 41,946,003.93	-3.02	1.15
DISTRICT 4	90	\$ 53,146,971.36	-6.73	1.56
DISTRICT 5	86	\$ 50,046,331.40	-11.28	2.57
DISTRICT 6	112	\$ 31,300,693.02	-11.86	2.11
DISTRICT 7	121	\$ 78,252,441.29	-2.00	1.19
DISTRICT 8	73	\$ 46,557,682.24	-4.76	1.30
DISTRICT 9	76	\$ 45,306,050.18	-3.63	1.33
DISTRICT 10	78	\$ 27,641,076.56	4.02	1.04
DISTRICT 11	82	\$ 50,248,009.84	-4.01	1.33
DISTRICT 12	74	\$ 39,558,747.79	4.89	1.08
TOTAL	1075	\$608,802,279.23	-3.84	1.50

Table 6.2: Summary of Bidding for All 12 Districts – Multi-bid, Single-bid and Tacit Collusion

DISTRICT	Multi-bid projects			Single-bid projects			Tacit Collusion	
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	# of Counties w/ tacit collusion AND increased bid levels	Financial Impact
DISTRICT 1	77	\$ 29,011,023.01	-6.41	27	\$ 13,010,518.50	1.81	4	\$ 928,149.29
DISTRICT 2	25	\$ 15,060,509.23	-9.28	81	\$ 87,716,220.88	2.31	9	\$ 8,921,983.04
DISTRICT 3	11	\$ 4,400,528.64	-14.64	62	\$ 37,545,475.29	-0.96	8	\$ 5,067,574.59
DISTRICT 4	33	\$ 21,427,367.84	-17.91	57	\$ 31,719,603.52	-0.25	10	\$ 4,980,890.92
DISTRICT 5	61	\$ 35,193,973.89	-15.67	25	\$ 14,852,357.51	-1.01	5	\$ 884,582.35
DISTRICT 6	84	\$ 22,290,906.84	-15.83	28	\$ 9,009,786.18	0.06	7	\$ 845,722.12
DISTRICT 7	22	\$ 5,314,648.58	-22.18	99	\$ 72,937,792.71	2.49	12	\$19,378,600.55
DISTRICT 8	22	\$ 7,113,228.85	-20.80	51	\$ 39,444,453.39	2.16	10	\$ 9,060,636.59
DISTRICT 9	24	\$ 12,048,815.80	-16.19	52	\$ 33,257,234.38	2.17	8	\$ 5,996,119.63
DISTRICT 10	3	\$ 491,156.00	3.85	75	\$ 27,149,920.56	4.03	10	\$ 4,974,946.94
DISTRICT 11	27	\$ 17,184,726.60	-20.42	55	\$ 33,063,283.24	4.05	8	\$ 8,226,358.58
DISTRICT 12	6	\$ 1,480,508.30	-0.78	68	\$ 38,078,239.49	5.39	3	\$ 1,329,901.48
TOTAL	395	\$171,017,393.58	-14.28	680	\$437,784,885.65	2.22	94	\$70,595,466.09

Table 6.3: Tacit Collusion by Firm

Firm	Colluding Rival	Number of Counties where they are potential competitors	Number of Counties where they collude
The Allen Company	Elmo Greer & Sons	8	8
	H.G. Mays	6	6
	Hinkle Contracting	14	14
	Mago Construction	11	11
	Nally & Gibson Georgetown	5	5
	Nally & Haydon Surfacing	6	2
	The Walker Company	6	6
ATS Construction	Barrett Paving	1	1
	H.G. Mays	3	3
	Hinkle Contracting	6	4
	Lincoln County Ready Mix	4	2
	Mago Construction	5	5
	Nally & Gibson Georgetown	2	2
	The Walker Company	3	3
Barrett Paving	ATS Construction	1	1
	H.G. Mays	4	4
	Hinkle Contracting	3	3
	Mago Construction	8	7
	Nally & Gibson Georgetown	2	2
Commercial Pavers	H.G. Mays	1	1
	Mago Construction	9	7
	Ohio Valley Asphalt	7	7
	Scotty's Contracting	5	4
	Shelbyville Asphalt	3	3
Eaton Asphalt Paving	H.G. Mays	8	3
	Hinkle Contracting	7	1
	Mago Construction	9	5
	Nally & Gibson Georgetown	4	4
	Ohio Valley Asphalt	7	6
	The Walker Company	4	4
Elmo Greer & Sons	The Allen Company	8	8
	ATS Construction	2	1
	Hinkle Contracting	11	11
	Lexington Quarry	2	2
	Lincoln County Ready Mix	4	2
	Mago Construction	3	3
	Mountain Enterprises	6	6
Gaddie-Shamrock	Hinkle Contracting	6	2
	Mago Construction	5	5
	Nally & Haydon Surfacing	6	6
	Scotty's Contracting	7	2
Glass Paving	Mago Construction	1	1
	Nally & Haydon Surfacing	5	5
	Scotty's Contracting	10	10

Table 6.3 (continued)

Firm	Colluding Rival	Number of Counties where they are potential competitors	Number of Counties where they collude
H.G. Mays	The Allen Company	6	6
	ATS Construction	3	2
	Barrett Paving	4	4
	Commercial Pavers	1	1
	Eaton Asphalt Paving	8	3
	Hinkle Contracting	9	8
	Lexington Quarry	3	3
	Lincoln County Ready Mix	3	1
	Mago Construction	12	11
	Mountain Enterprises	3	2
	Nally & Gibson Georgetown	3	3
	Nally & Haydon Surfacing	3	3
	Shelbyville Asphalt	2	2
	The Walker Company	7	7
Hinkle Contracting	The Allen Company	14	14
	ATS Construction	6	3
	Barrett Paving	3	3
	Eaton Asphalt Paving	7	1
	Elmo Greer & Sons	11	11
	Gaddie-Shamrock	6	2
	H.G. Mays	9	8
	Lexington Quarry	4	4
	Lincoln County Ready Mix	6	2
	Mago Construction	13	11
	Mountain Enterprises	15	14
	Nally & Gibson Georgetown	5	5
	Nally & Haydon Surfacing	3	3
	Shelbyville Asphalt	1	1
	The Walker Company	15	13
Jim Smith Contracting	Road Builders	2	1
	Rogers Group	7	7
Lexington Quarry	Elmo Greer & Sons	2	2
	H.G. Mays	3	3
	Hinkle Contracting	4	4
	Lincoln County Ready Mix	5	3
	Mago Construction	4	3
	Nally & Gibson Georgetown	3	3
Lincoln County Ready Mix	ATS Construction	4	2
	Elmo Greer & Sons	4	2
	H.G. Mays	3	1
	Hinkle Contracting	6	2
	Lexington Quarry	5	3
	Mago Construction	8	8
	Nally & Gibson Georgetown	3	3
	Nally & Haydon Surfacing	6	6

Table 6.3 (continued)

Firm	Colluding Rival	Number of Counties where they are potential competitors	Number of Counties where they collude
Mago Construction	The Allen Company	11	11
	ATS Construction	6	6
	Barrett Paving	8	7
	Commercial Pavers	9	7
	Eaton Asphalt Paving	9	5
	Elmo Greer & Sons	3	3
	Gaddie-Shamrock	5	5
	Glass Paving	1	1
	H.G. Mays	12	11
	Hinkle Contracting	13	11
	Lexington Quarry	4	3
	Lincoln County Ready Mix	8	8
	Nally & Gibson Georgetown	8	8
	Nally & Haydon Surfacing	9	9
	Scotty's Contracting	10	8
	Shelbyville Asphalt	8	7
	The Walker Company	1	1
	Yager Materials	3	2
Mountain Enterprises	Elmo Greer & Sons	6	6
	H.G. Mays	3	2
	Hinkle Contracting	15	14
	The Walker Company	4	2
Murray Paving	Rogers Group	4	2
Nally & Gibson Georgetown	The Allen Company	5	5
	ATS Construction	2	2
	Barrett Paving	2	2
	Eaton Asphalt Paving	4	4
	H.G. Mays	3	3
	Hinkle Contracting	5	5
	Lexington Quarry	3	3
	Lincoln County Ready Mix	3	3
	Mago Construction	8	8
	Shelbyville Asphalt	2	2
Nally & Haydon Surfacing	The Allen Company	6	2
	Gaddie-Shamrock	6	6
	Glass Paving	5	5
	H.G. Mays	3	3
	Hinkle Contracting	3	3
	Lincoln County Ready Mix	6	6
	Mago Construction	9	9
	Scotty's Contracting	9	6
Ohio Valley Asphalt	Commercial Pavers	7	7
	Eaton Asphalt Paving	7	6
Road Builders	Jim Smith Contracting	2	1
	Rogers Group	11	6
	Scotty's Contracting	7	6
	Yager Materials	5	3

Table 6.3 (continued)

Rogers Group	Jim Smith Contracting	7	7
	Murray Paving	4	2
	Road Builders	11	6
	Scotty's Contracting	5	4
	Yager Materials	5	4
Scotty's Contracting	Commercial Pavers	5	4
	Gaddie-Shamrock	7	2
	Glass Paving	10	10
	Mago Construction	10	8
	Nally & Haydon Surfacing	9	6
	Road Builders	7	6
	Rogers Group	5	4
	Yager Materials	4	3
Shelbyville Asphalt	Commercial Pavers	3	3
	H.G. Mays	2	2
	Hinkle Contracting	1	1
	Mago Construction	8	7
	Nally & Gibson Georgetown	2	2
The Walker Company	The Allen Company	6	6
	ATS Construction	3	3
	Eaton Asphalt Paving	4	4
	H.G. Mays	7	7
	Hinkle Contracting	15	13
	Mago Construction	1	1
	Mountain Enterprises	4	2
	Nally & Gibson Georgetown	1	1
Yager Materials	Mago Construction	3	2
	Road Builders	4	1
	Rogers Group	5	4
	Scotty's Contracting	4	3

6.2 District 1 – Western Kentucky

District 1 consists of firms in Western Kentucky (see Figure 6.1). There are four firms that have plants located in this district and that compete on projects: H&G Construction, Jim Smith Contracting, Murray Paving, and Rogers Group.¹¹⁴ There are 12 counties in this district where firms compete for projects. The pattern of bidding that emerges in District 1 is that H&G Construction and Jim Smith Contracting bid against each other on most projects in all the counties except Crittenden and Trigg. Rogers Group does not bid in any of these counties where H&G Construction and Jim Smith Contracting bid. There is evidence that Rogers Group and Jim Smith Contracting are tacitly colluding and not bidding in each other's territories. There is not conclusive evidence for the other firms. The result of this refusal to bid in counties where the other firm has an asphalt plant is that bid levels are \$928,149.29 higher than if there were multiple bidders. Table 6.4 summarizes these results. There is evidence of tacit collusion in Lyon and Livingston Counties because Rogers Group avoids bidding in these counties and Jim Smith Contracting does not bid in Rogers Group's counties. Since there are already two bidders actively bidding, a financial impact of this avoidance of bidding is negligible. These counties have tacit collusion between these firms, but the fact that bids are so competitive drives bid levels. At this point it is hard to distinguish if this is a strict result of strategic behavior on the part of the firms or a realization that bids are so low Rogers Group's costs do not justify bidding.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data, bid functions, the existence and/or extent of tacit collusion. To aid this discussion summary statistics and result tables are provided in Table 6.4, Table 6.5, Table 6.6, and Table 6.7. A map for each firm follows the tables. The additional regression results found in Table 6.7 only includes the county variables and variations on the county variables are displayed. The other control variables were included in this regression. After the

¹¹⁴ Murray Paving was owned by Jim Smith Contracting during the time period of 2005-2007. I initially had these two firms combined under Jim Smith Contracting. However, during further analysis I saw that at times these two firms purchased bid proposals on nine of the same projects. Eight of the projects were in Calloway County and one of the projects was in Hickman County. The two firms do not bid against each other on any of the projects, but Jim Smith Contracting does bid in Calloway County. These firms are able to coordinate bids since they are under the same ownership. The firms are kept separate for this analysis. Source of ownership: "Kentucky.Gov Fasttrack Business Organization Search," <https://app.sos.ky.gov/ftsearch/default.aspx>.

section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.2.1 Firms with Asphalt Plants in District 1

H.G. Construction

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

H&G Construction has one plant located in District 1 in Graves County. Jim Smith Contracting also has an asphalt plant in this county. Their primary competitors are Jim Smith Contracting and Rogers Group. They bid on 77 projects which were all in District 1. Of those 77 projects they were awarded contracts for 14 of those contracts. The contracted value of the 77 projects they bid on was \$29,011,023.01. The average number of bidders on 77 projects was 2.00 bids. Every project they bid on had two bidders. The contracted bid of these 77 projects averaged 6.41 percent below the engineer's estimate compared to an average, for all asphalt projects in Kentucky, of 3.84 percent that is below the engineer's estimate. The fact that there are two bidders puts downward pressure on bids. Table 6.5 shows the summary statistics for the 60 mile service area. Of the 97 projects in the 60-mile service area, 39 projects are within the 21 to 30 mile band from the plant. H&G Construction bid on 38 of those projects. More than 90 percent of 97 projects had one competitor purchasing bid proposals for the project. This was typically Jim Smith Contracting. Most of the projects (over 80 percent) they bid on were outside Graves County. To understand more of H&G Construction's bid behavior a bid function was constructed.

FIRM BID FUNCTION

The purpose of the bid function is to see what factors influence whether H&G Construction bids on a project. The bid function for H&G Construction is in Table 6.7. The first sets of variables are the distance variables. Without the county control variables, the firm is less likely to bid on a project only if it is beyond 40 miles. This variable is not significant when the county variables are added, either. This is an indication that distance is not an important factor in whether H&G Construction bids on a project. Looking at Figure 6.2 the map also confirms this fact. One factor that significantly impacts whether they bid on a project is the number of jobs they have under contract at the time of the bid. This coefficient is positive and indicates they are more likely to bid on a project the more projects they are working on. This could result from a

number of different factors such as having a lot of extra capacity since they bid on a lot of project but only win 19 percent. The number of potential competitors is negative and significantly impacts whether they will bid on a project. A couple of conclusions can be drawn from these results. H&G Construction is a firm that bids on over 80 percent of all projects they can bid on but does not win many of them. County boundaries do not impact whether they bid on a project. Distance seems to have some influence, but only when a project is more than 40 miles away from their plant. They are one of the few truly competitive firms in Kentucky. The main factor that seems to influence whether they bid is the fact that a project is available to be bid on. There is no pattern that emerges why they do not bid on the 20 other projects.

JIM SMITH CONTRACTING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Jim Smith Contracting has three asphalt plants all located in District 1. They are located in Graves, Livingston, and McCracken Counties. H&G Construction has an asphalt plant located in Graves County, also. Their primary competitors are H&G Construction and Rogers Group. Jim Smith Contracting bids on 86 projects which were all in District 1. Of those 86 projects they bid on, they were awarded contracts for 71 of those projects. The contracted value of the 86 projects they bid on was \$35,174,225.41. The average number of bidders on the 86 projects was 1.86 bids. There were 12 of the 86 projects that Jim Smith Contracting was the lone bidder. The contracted bid of these 12 single-bid projects averaged 1.18 percent below the engineer's estimate. The multi-bid average for District 1 is 6.41 percent below the engineer's estimate. The contractual value of these single-bid contracts is \$7,485,568.20. The fact that there are two bidders on most of the bids and the threat that H&G Construction could bid on most projects puts downward pressure on bids. To understand more of Jim Smith Contracting bid behavior a bid function was constructed.

FIRM BID FUNCTION

The purpose of the bid function is to see what factors influence whether Jim Smith Contracting bids on a project. The bid function for Jim Smith Contracting is in Table 6.6. The first set of variables is the distance variables. Under specification (A), the distance variable is negative and significant for jobs over 20 miles away from their asphalt plants. The significance changes to more than 40 miles when the county variables are added in specification (B). The magnitude of these variables becomes greater as the projects get further away. This means that

for projects beyond 20 miles (or 40 miles) they are less likely to bid on projects than those less than 20 miles (or 40 miles) from their plants. The number of bid proposals purchased by competitors is significant and negative to some degree for both specifications. This means that they are less likely to bid on a project with one or more other firms have purchased bid proposals than one where they are the only bidder.

When the county variables are added, they significantly impact the probability of Jim Smith Contracting bidding on a project. The reference category is all projects in a county where Jim Smith Contracting has an asphalt plant. The results for the county variables need to be understood from the perspective that a firm is either more or less likely to bid on projects outside the county where they have an asphalt plant. The “Project in same county-rival” and “Project in adjacent county-no rival” are not significant but are negative. Looking at Figure 6.3, Jim Smith Contracting bids on every project in Graves County and in counties where there are no asphalt plant. “Project in adjacent county-rival” is negative and significant when the other factors that influence bidding are controlled. They are, on average, 62.4 percent less likely to bid on a project if it is in a county where a rival firm has an asphalt plant. Whether this is because of tacit collusion will be explored on a county-by-county basis after the Rogers Group section.

MURRAY PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Murray Paving has one asphalt plant located in District 1 in Calloway County. Their primary competitors are H&G Construction and Rogers Group. Since Murray Paving and Jim Smith Contracting are owned by the same people, they can coordinate bids and not bid against each other. Murray Paving only bids on four projects all in District 1. The four projects are in Calloway County (see Figure 6.4). They were awarded the four projects. The contracted value of the four projects they bid on was \$1,765,535.60.¹¹⁵ The average number of bidders on the four projects was 1.75 bids. H&G Construction bid against them on all but one project. There was

¹¹⁵ If you look at Figure 6.4, there are more than four dots in Calloway County. This is because these four projects have multiple roads bundled into the one project. Projects 62062 and 72133 have only one road that needs paving. Therefore they have only one red dot associated with the project. Project 63112 has six roads that need paving bundled into this one project. Project 73179 has 12 roads bundled into this one project. Each one of these components is represented by a dot on the map. That is why there are more than four dots in Calloway County for Murray Paving.

only one project with a single bidder. The contracted value was 7.66 percent below the engineer's estimate. The other three projects averaged 0.23 percent above the engineer's estimate. To understand more of Murray Paving bid behavior a bid function was constructed.

FIRM BID FUNCTION

The purpose of the bid function is to see what factors influence whether Murray Paving bids on a project (see Table 6.6). The first set of variables is the distance variables. Under both specifications, with (A) and without county variables (B), the distance variable is negative and significant for jobs over 20 miles away from their asphalt plant. This means that for projects beyond 20 miles they are less likely to bid on projects than those less than 10 miles from their plant.

When the county variables (B) are added, they do not significantly impact the probability of Murray Paving bidding. It appears that they only bid in Calloway County because Jim Smith Contracting bids in the surrounding counties. They also avoid bidding against the Rogers Group. The bidding behavior of Murray Paving will be explored on a county-by-county basis after the Rogers Group section.

ROGERS GROUP

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Rogers Group has two of their five plants located in District 1 in Crittenden and Trigg Counties. No other firms have asphalt plants in these two counties. Their primary competitors in District 1 are H&G Construction and Jim Smith Contracting, however in other districts they compete against Road Builders & Parkway Construction, Scotty's Contracting and Stone, and Yager Materials. They bid on 14 projects in District 1. It is interesting to note that all of these projects are only in Crittenden and Trigg Counties. Of those 14 projects they were awarded contracts for all 14 projects. The contracted value of the 14 projects they bid on was \$5,081,780.50. Rogers Group is the only bidder on these projects. The contracted bid of these 14 projects averaged 5.05 percent above the engineer's estimate compared to an average, for all asphalt projects in Kentucky, of 3.84 percent below the engineer's estimate. Table 6.5 shows the summary statistics for the 60 mile service area for Rogers Group. Of the 194 projects in the 60-mile service area, over half of the projects are in counties where a rival firm has an asphalt plant. Since so many projects are in those counties, it would be expected that they would bid on

those projects. However, they only bid on two projects in Hopkins County.¹¹⁶ To understand more of Rogers Group bid behavior a bid function was constructed.

FIRM BID FUNCTION

The purpose of the bid function is to see what factors influence whether Rogers Group bids on a project. The bid function is for all projects in their 60 mile service area. This includes projects in District 1 and District 2 where they bid. The bid function for Rogers Group is in Table 6.6. The first set of variables is the distance variables. Rogers Group is less likely to bid on a project if it is beyond 20 miles (see “A”) and 30 miles (see “B”) of their asphalt plants when the county variables are added. The different distance variables are all negative and significant. The magnitudes also increase indicating as the distance increases they are less likely to bid on projects. The engineer’s estimate variable is positive and significant. This means the more value a project has the more likely they are to bid on the project. The set of competitor variables including the number of potential competitors and the number of bid proposals purchased by competitors are negative and significant. Rogers Group’s probability of bidding is negatively impacted by the threat of competition.

When the county variables are added, they significantly impact the probability of Rogers Group bidding on a project. They are more likely to bid on a project in a county such as Crittenden and Trigg Counties where they have an asphalt plant than an adjacent county such as Lyon County where there is no rival asphalt plant. In Figure 6.5 it is clear Rogers Group sticks primarily to counties where they have asphalt plants and avoids counties where rival firms have asphalt plants. When there is an asphalt plant in an adjacent county (see Livingston County) where Jim Smith Contracting has asphalt plants they are less likely to bid on a project. The bidding behavior of Rogers Group will be explored on a county-by-county basis in the next section.

¹¹⁶ Looking at Figure 6.5 the Rogers Group map, it appears there are more than two bids in the county. However, some projects have multiple parts within the county as is this case. Multiple road segments can be bundled into one bid and this typically occurs within the same county.

6.2.2 *Counties in District 1*

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions. However, these variables were not displayed due to lack of space. The nature of the competition will be defined and whether there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

BALLARD, CARLISLE, FULTON, AND HICKMAN COUNTIES

There are a total of 27 projects in Ballard, Carlisle, Fulton and Hickman Counties. The total contracted value of these projects is \$6,712,521.53. These projects contracted value averages 7.07 percent below the engineer's estimate. The competitive or multi-bid average for projects in District 1 is 6.41 percent below the engineer's estimate (see Table 6.4). There are three potential competitors that could reasonably bid on projects in these counties: H&G Construction, Jim Smith Contracting, and Murray Paving. Murray Paving cannot bid on all projects in Ballard County, and therefore they are not a potential competitor in Ballard County. H&G Construction and Jim Smith Contracting both bid on projects in these four counties. If you look at the additional regressions (see Table 6.7) and look at specification "D" where the county variables are broken out none of them are significantly different than zero. This means these three firms are bidding similar to how they bid in counties where they have asphalt plants. There is clear evidence that there is no tacit collusion occurring in these four counties.

LYON AND MARSHALL COUNTIES

There are a total of 13 projects in Lyon and Marshall Counties. The total contracted value of these projects is \$4,575,710.24. The 13 projects contracted value averages 5.67 percent below the engineer's estimate. The competitive or multi-bid average for projects in District 1 is 6.41 percent below the engineer's estimate (see Table 6.4). There are four projects, two in Lyon County and two in Marshall County, with only one bidder: Jim Smith Contracting. The contracted

value of the two bids average 4.36 percent below the engineer's estimate, and the contracted value of the other nine projects average 6.26 percent below the engineer's estimate.

The next question is whether there is evidence of tacit collusion. In Lyon and Marshall County the potential competitors are H&G Construction, Jim Smith Contracting, Murray Paving, and Rogers Group. Murray Paving does not bid against Jim Smith Contracting since they are under the same ownership. Scotty's Contracting is not considered a potential competitor because they cannot service all of the projects in Lyon and Marshall Counties. According to the additional regression, Rogers Group does not bid on any projects in these two counties (see Table 6.7). The Lyon and Marshall County variables are negative and significant. This means that Rogers Group is bidding differently in these counties than the counties where they have asphalt plants. Looking at Figure 6.5 it is clear that Rogers Group is avoiding bidding in Lyon and Marshall County. They bid on other projects in counties such as Webster and Union that are in the 11 to 20 and 21 to 30 mile rings; however they do not bid on any projects in Lyon and Marshall Counties at similar distances. Why? It appears to be a tit-for-tat behavior with Jim Smith Contracting where Rogers Group avoids bidding where Jim Smith Contracting bids and vice versa. This extends into District 2. Since H&G Construction is so active in bidding, it does not appear that the lack of Rogers Group bidding significantly impacts the contracted value of the bids.

Multi-bid projects average 6.41 below the engineer's estimate for District 1. In Lyon County the single-bid contracts average 8.15 percent below the engineer's estimate. This is largely due to H&G Construction being an active bidder in Lyon County. Therefore, the impact of the tacit collusion between Jim Smith Contracting and Rogers Group is negligible. This county is designated as "competitive" in the "financial impact" column of Table 6.4. However in Marshall County the contracted value for the single-bid contracts averages 0.57 percent below the engineer's estimate or about \$39,818.80 above the competitive level for District 1. Since tacit collusion is characterized by firms' refusal to bid on projects, it results in single-bid contracts and can lead to bids above the competitive level. This is evidence that the strategic component of bidding by a firm, characterized by a firm not bidding in a county, can drive up bid levels. In this case it is not by very much. While firms may merely avoid bidding in a county due to it being competitive and the bid levels being low, it is the higher bid levels that indicate the importance of the strategic component plays in the bidding.

COUNTIES WITH ASPHALT PLANTS

CALLOWAY, GRAVES, LIVINGSTON, AND MCCrackEN COUNTIES

There are 50 projects in these four counties. Jim Smith Contracting has an asphalt plant in three counties (Graves, Livingston and McCracken Counties). Murray Paving has an asphalt plant in Calloway County, and H&G Construction has an asphalt plant in Graves County. The contracted value of these projects is \$25,651,538.24. The 50 projects contracted value averages 5.01 percent below the engineer's estimate. There are eight projects with only one bidder: Jim Smith Contracting. The contracted value of the eight bids average 0.92 percent below the engineer's estimate, and the contracted value of the other 48 projects average 5.79 percent below the engineer's estimate.

Like the counties without asphalt plants, there are two firms that bid on a majority of projects in these counties: H&G Construction and Jim Smith Contracting. Murray Paving bids only on projects in Calloway County. Rogers Group does not bid on any projects in these counties. Looking at the "C" specification in Table 6.7, Rogers Group is less likely to bid in counties where Jim Smith Contracting and Murray Paving have asphalt plant. This is returned by Jim Smith Contracting but not by Murray Paving. This brings up the issue discussed briefly in the last section. Rogers Group avoids bidding in counties with rival firms in District 1. The tit-for-tat behavior is that Rogers Group does not bid where Jim Smith Contracting has asphalt plants or bids and Jim Smith Contracting returns the favor. This is true in Graves, Livingston Counties where Rogers Group is a potential bidder. Rogers Group is not a potential competitor in McCracken County because they cannot bid on every project in the county. Having Rogers Group bid in these two counties would drive the bids down further.

In Calloway County, Murray Paving does not bid against Rogers Group (see Figure 6.4). Since they are owned by Jim Smith Contracting, they do not bid against Jim Smith Contracting. However, both firms purchase bid proposals on the same projects and bid and win projects in Calloway County. There is evidence of tacit collusion between Murray Paving and Rogers Group since Murray Paving follows the behavior of Jim Smith Contracting. However, the effect is negligible since bid levels are so low. One thing that keeps this tacit collusion from driving bid levels higher is that H&G Construction is actively bidding on projects in these counties. The

financial impact of this tacit collusion in Graves and Livingston Counties is that the contracted value of the single-bid projects is \$303,925.51 above the competitive level.

CRITTENDEN AND TRIGG COUNTIES

There are 14 projects in Crittenden and Trigg Counties. Rogers Group has an asphalt plant in each county. The contracted value of these 14 projects is \$5,081,780.50 which averages 5.05 percent above the engineer's estimate. All 14 projects were bid on only by Rogers Group. Jim Smith Contracting avoids bidding in Crittenden and Trigg counties as well as Caldwell County (District 2). In other counties in District 1, Jim Smith Contracting is bidding on projects that are more than 30 miles away from their plants (see Figure 6.3). However, they do not bid on projects in Crittenden and Trigg Counties that are similar distances away from their plants. Clearly, county boundaries are impacting whether or not Jim Smith Contracting bids in those counties. The additional results discussed in the previous section verify this fact. Jim Smith Contracting and Rogers Group avoid bidding in each county where they have their respective asphalt plant. Murray Paving avoids bidding in Trigg County. Scotty's Contracting has an asphalt plant in District 3 in Todd County and are potential competitors in Trigg County. However, they do not bid on any of the projects. Table 6.7 shows they are less likely to bid on projects in counties where Rogers Group has asphalt plants, and Table 6.7 shows that Rogers Group is less likely to bid in counties where Scotty's Contracting has an asphalt plant. This is evidence of tacit collusion between these firms. Road Builders has asphalt plants in Hopkins and Muhlenberg Counties. While the regression results are not conclusive, there is evidence that Road Builders avoids bidding on projects in Crittenden County (see Table 6.7 and Figure 6.7 in the next section). The financial impact in Crittenden County is that projects are \$297,088.29 higher than the competitive level. In Trigg County single-bid contracts are \$287,316.70 above the competitive level.

CONCLUSION

In conclusion, the pattern of bidding that emerges in District 1 is that H&G Construction and Jim Smith Contracting bid against each other on most projects. Murray Paving sticks to bidding in Calloway County and there is evidence that they collude with Rogers Group. Murray Paving is owned by Jim Smith Contracting and so these two firms are not considered competitors. Rogers Group does not bid in the counties where these firms bid. There is

conclusive evidence that Jim Smith Contracting returns the favor and does not bid in Crittenden and Trigg Counties where Rogers Group has their asphalt plants. Road Builders and Scotty's Contracting also do not bid in these counties. The effect of the tacit collusion is negligible on bids in Lyon and Livingston Counties compared to the competitive level of the district. However, in Crittenden, Graves, McCracken and Trigg Counties bids average above the competitive level. The result is that bids in these counties are \$928,149.29 higher as a result of the lack of competition.

Table 6.4: Summary of Bidding and Tacit Collusion for District 1 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Ballard	7	\$1,519,136.80	-6.66				No	-	Competitive
Carlisle	5	\$2,010,660.86	-8.39				No	-	Competitive
Fulton	8	\$1,792,374.53	-5.39	1	\$578,249.00	2.96	No	-	Competitive
Hickman	6	\$812,091.34	-10.38				No	-	Competitive
Lyon	2	\$395,509.50	-7.55	2	\$519,354.80	-8.15	Yes	Two Firms (A)	Competitive
Marshall	7	\$2,979,017.14	-5.89	2	\$681,828.80	-0.57	Yes	Two Firms (A)	\$39,818.80
TOTAL (WITHOUT ASPHALT PLANTS)	35	\$9,508,790.17	-7.15	5	\$1,779,432.60	-2.89			
WITH ASPHALT PLANTS									
Calloway	8	\$3,432,404.12	-4.95	1	\$443,169.80	-7.66	Yes	Two Firms (B)	Competitive
Crittenden				8	\$2,713,135.03	4.54	Yes	Three Firms (C)	\$297,088.29
Graves	10	\$8,963,341.45	-7.05	3	\$4,244,769.70	0.75	Yes	Two Firms (A)	\$303,925.51
Livingston	5	\$1,480,556.53	-1.32	2	\$1,014,955.20	-6.32	Yes	Two Firms (A)	Competitive
McCracken	19	\$5,625,930.74	-6.64	2	\$446,410.70	5.34	No	-	Competitive
Trigg				6	\$2,368,645.47	5.72	Yes	Four Firms (D)	\$287,316.70
TOTAL (WITH ASPHALT PLANTS)	42	\$19,502,232.84	-5.79	22	\$11,231,085.90	-0.92			
TOTAL (DISTRICT 1)	77	\$29,011,023.01	-6.41	27	\$13,010,518.50	1.81			\$928,149.29

(A) These firms include Jim Smith Contracting and Rogers Group

(B) These firms include Murray Paving and Rogers Group

(C) These firms include Jim Smith Contracting, Road Builders, and Rogers Group

(D) These firms include Jim Smith Contracting, Murray Paving, Rogers Group, and Scotty's Contracting

Table 6.5: Summary Statistics for District 1 Firms

	H&G Construction		Jim Smith Contracting		Murray Paving		Rogers Group	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.794	0.407	0.610	0.49	0.0408	0.199	0.284	0.452
Distance Variables								
Distance (0 to 10 miles) [reference variable]	0.0515	0.222	0.135	0.343	0.0510	0.221	0.0928	0.291
Distance (11 to 20 miles)	0.155	0.363	0.184	0.389	0.102	0.304	0.129	0.336
Distance (21 to 30 miles)	0.402	0.493	0.213	0.411	0.102	0.304	0.237	0.426
Distance (31 to 40 miles)	0.155	0.363	0.184	0.389	0.133	0.341	0.237	0.426
Distance (41 to 50 miles)	0.155	0.363	0.113	0.318	0.388	0.49	0.144	0.352
Distance (51 to 60 miles)	0.0825	0.277	0.170	0.377	0.224	0.419	0.160	0.367
Other Control Variables								
Jobs Under Contract	3.464	1.217	6.362	2.227	0.0714	0.259	3.814	2.332
Engineer's Estimate	426,135	591,890	476,065	687,203	491,427	735,758	751,658	1.88E+06
Competitive Variables								
Number of Potential Competitors	3.887	0.877	4.014	0.886	4.020	0.837	1.464	0.735
Zero other competitive bid proposal purchased [reference variable]	0	-	0.0284	0.167	0	-	0.180	0.386
One other competitive bid proposal purchased	0.918	0.277	0.872	0.335	0.173	0.381	0.381	0.487
Two other competitive bid proposals purchased	0.0825	0.277	0.0780	0.269	0.827	0.381	0.351	0.478
Three or more other competitive bid proposals purchased	0	-	0.0213	0.145	0	-	0.0876	0.283
County Variables								
Project in same county-no rival	0	-	0.199	0.4	0.0918	0.29	0.191	0.394
Project in same county-rival	0.134	0.342	0.0922	0.29	0	-	0	-
Project in adjacent county-no rival [reference variable]	0.412	0.495	0.333	0.473	0.378	0.487	0.227	0.42
Project in adjacent county-rival	0.454	0.5	0.376	0.486	0.133	0.341	0.582	0.494
Observations	97		141		98		194	

Table 6.6: Regression results for District 1 Firms

VARIABLES	H&G Construction		Jim Smith Contracting		Murray Paving		Rogers Group	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	0.0608 (0.240)	0.138 (0.245)	0.0400 (0.0311)	0.0299 (0.0230)	-0.198 (0.262)	-0.164 (0.269)	-0.0895 (0.0739)	-0.0304 (0.0582)
Distance (21 to 30 miles)	0.18 (0.237)	0.351 (0.287)	-0.183*** (0.0594)	-0.0340 (0.0256)	-0.413* (0.230)	-0.391* (0.232)	-0.410*** (0.0872)	-0.150 (0.107)
Distance (31 to 40 miles)	0.137 (0.242)	0.314 (0.294)	-0.680*** (0.0977)	-0.128 (0.0872)	-0.400* (0.230)	-0.395* (0.232)	-0.554*** (0.0895)	-0.301*** (0.113)
Distance (41 to 50 miles)	-0.00846 (0.268)	0.179 (0.320)	-0.624*** (0.109)	-0.285** (0.111)	-0.394* (0.230)	-0.385 (0.232)	-0.633*** (0.0837)	-0.312*** (0.109)
Distance (51 to 60 miles)	-0.406 (0.275)	-0.240 (0.315)	-0.840*** (0.0429)	-0.408*** (0.103)	-0.405* (0.231)	-0.399* (0.232)	-0.622*** (0.0831)	-0.317*** (0.111)
Jobs Under Contract	0.0768** (0.0313)	0.0750** (0.0313)	-0.0219* (0.0111)	-0.0183* (0.00953)	0.131 (0.112)	0.150 (0.114)	0.00127 (0.00757)	0.000431 (0.00615)
Engineer's Estimate	-2.60e-08 (7.82e-08)	-3.41e-08 (7.89e-08)	-2.04e-08 (1.87e-08)	1.97e-08 (2.53e-08)	-1.39e-08 (1.70e-08)	-2.52e-08 (1.90e-08)	1.90e-08*** (6.17e-09)	2.15e-08*** (6.13e-09)
Number of Potential Competitors	-0.131** (0.0596)	-0.142* (0.0726)	-0.157*** (0.0357)	-0.0413* (0.0245)	0.0190 (0.0131)	-0.00455 (0.00856)	-0.0832*** (0.0201)	-0.0778*** (0.0161)
One competitive bid proposal purchased	0.0110 (0.113)	0.0280 (0.121)	-0.0674 (0.0604)	-0.0673* (0.0395)	-0.0521 (0.0414)	-0.149 (0.0958)	-0.458*** (0.0857)	-0.287*** (0.0945)
Two competitive bid proposals purchased			-0.0289 (0.183)	-0.0395 (0.184)			-0.496*** (0.0844)	-0.351*** (0.0911)
Three or more competitive bid proposals purchased			-0.310** (0.143)	-0.533*** (0.155)			-0.540*** (0.0885)	-0.379*** (0.0978)
Project in same county-rival				-0.0254 (0.0268)				
Project in adjacent county-no rival		-0.204 (0.206)		-0.0377 (0.0308)		-0.0398 (0.0288)		-0.204* (0.107)
Project in adjacent county-rival		-0.163 (0.181)		-0.624*** (0.0966)		0.155 (0.0964)		-0.474*** (0.123)
Constant	0.971** (0.383)	1.015** (0.405)	1.828*** (0.188)	1.332*** (0.131)	0.330 (0.236)	0.429* (0.236)	1.453*** (0.102)	1.398*** (0.0827)
Observations	97	97	141	141	98	98	194	194
R-squared	0.421	0.430	0.689	0.796	0.306	0.328	0.734	0.797

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.7: Additional regression results for District 1 firms and firms outside District 1

VARIABLES	H&G Construction			Jim Smith Contracting			Murray Paving			Rogers Group		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival				-0.0254 (0.0268)	-0.0471** (0.0217)	0.0273 (0.0202)						
Project in adjacent county-no rival	-0.204 (0.206)	-0.188 (0.212)		-0.0377 (0.0308)	-0.0342 (0.0213)		-0.0398 (0.0288)	-0.0398 (0.0288)		-0.204* (0.107)	-0.192** (0.0953)	
Project in adjacent county-rival	-0.163 (0.181)		-0.173 (0.185)	-0.624*** (0.0966)		-1.008*** (0.0624)	0.155 (0.0964)		0.133 (0.0984)	-0.474*** (0.123)		-0.421*** (0.124)
Project in adjacent county-H&G Construction								0 (0)			-0.00830 (0.0189)	
Project in adjacent county-Jim Smith		-0.178 (0.185)						0 (0)			-0.416*** (0.111)	
Project in adjacent county-Murray Paving		-0.134 (0.219)			0.230 (0.152)						-0.532*** (0.109)	
Project in adjacent county-Road Builders					-0.688*** (0.115)						-0.461*** (0.146)	
Project in adjacent county-Rogers Group		-0.679* (0.349)			-0.885*** (0.0751)			0.155 (0.0964)				
Project in adjacent county-Scotty's Contracting											-0.616*** (0.130)	
Project in Ballard County			-0.319 (0.246)			0.0647 (0.0428)			0.0421 (0.0552)			
Project in Carlisle County			-0.213 (0.208)			0.0415 (0.0319)			-0.00247 (0.0368)			
Project in Fulton County			-0.257 (0.245)			0.00381 (0.0394)			0.0127 (0.0389)			
Project in Hickman County			-0.259 (0.217)			-0.0251 (0.0388)			0.0214 (0.0379)			
Project in Lyon County			-0.184 (0.416)			0.00855 (0.0281)			-0.0347 (0.0511)			-0.583*** (0.120)
Project in Marshall County			-0.187 (0.241)			0.0233 (0.0178)			-0.113 (0.0762)			-0.488*** (0.120)
Constant	1.015** (0.405)	0.707* (0.393)	1.104** (0.494)	1.332*** (0.131)	1.130*** (0.0810)	1.042*** (0.0873)	0.429* (0.236)	0.429* (0.236)	0.332 (0.263)	1.398*** (0.0827)	1.510*** (0.0982)	1.181*** (0.0580)
Observations	97	97	97	141	141	141	98	98	98	194	194	194
R-squared	0.430	0.460	0.433	0.796	0.885	0.912	0.328	0.328	0.341	0.797	0.812	0.926

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.7 (continued)

VARIABLES	Road Builders & Parkway Construction			Scotty's Contracting and Stone		
	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival				-0.181* (0.108)	-0.166 (0.112)	-0.218* (0.114)
Project in adjacent county-no rival	0.328** (0.152)	0.329** (0.152)		-0.189*** (0.0625)	-0.0616 (0.0731)	
Project in adjacent county-rival	0.141 (0.165)		-0.274 (0.171)	-0.544*** (0.0708)		-0.648*** (0.106)
Project in adjacent county-H&G Construction						
Project in adjacent county-Jim Smith		0.174 (0.162)				
Project in adjacent county-Murray Paving						
Project in adjacent county-Road Builders					-0.347*** (0.0913)	
Project in adjacent county-Rogers Group		0.123 (0.169)			-0.427*** (0.0955)	
Project in adjacent county-Scotty's Contracting		0.111 (0.168)				
Project in Ballard County						
Project in Carlisle County						
Project in Fulton County						
Project in Hickman County						
Project in Lyon County			-0.259 (0.169)			-0.652*** (0.106)
Project in Marshall County						-0.629*** (0.109)
Constant	1.016*** (0.0766)	1.076*** (0.0927)	1.093*** (0.0744)	1.024*** (0.0426)	1.065*** (0.0506)	0.960*** (0.0340)
Observations	157	157	157	339	339	339
R-squared	0.825	0.827	0.901	0.740	0.749	0.849

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.1: District 1

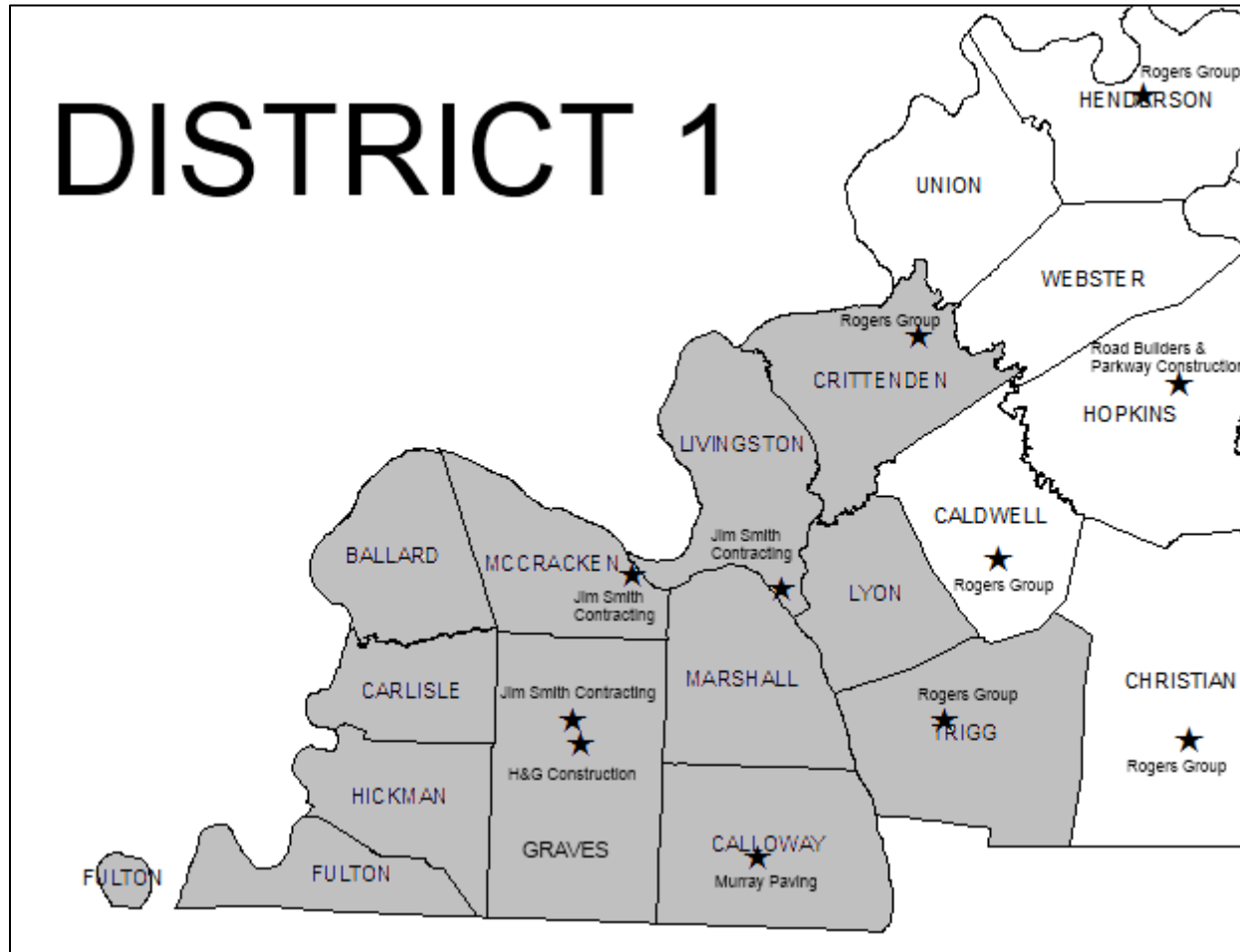


Figure 6.2: H&G Construction Company Service Area

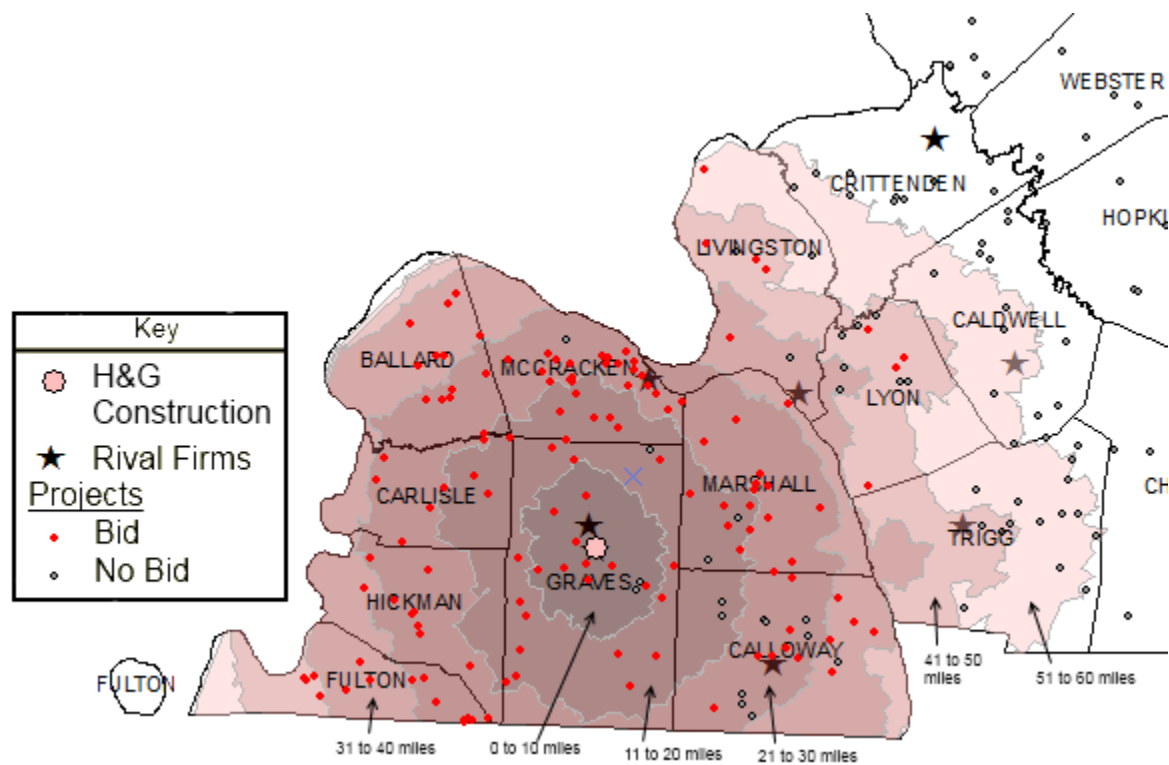


Figure 6.3: Jim Smith Contracting Service Area

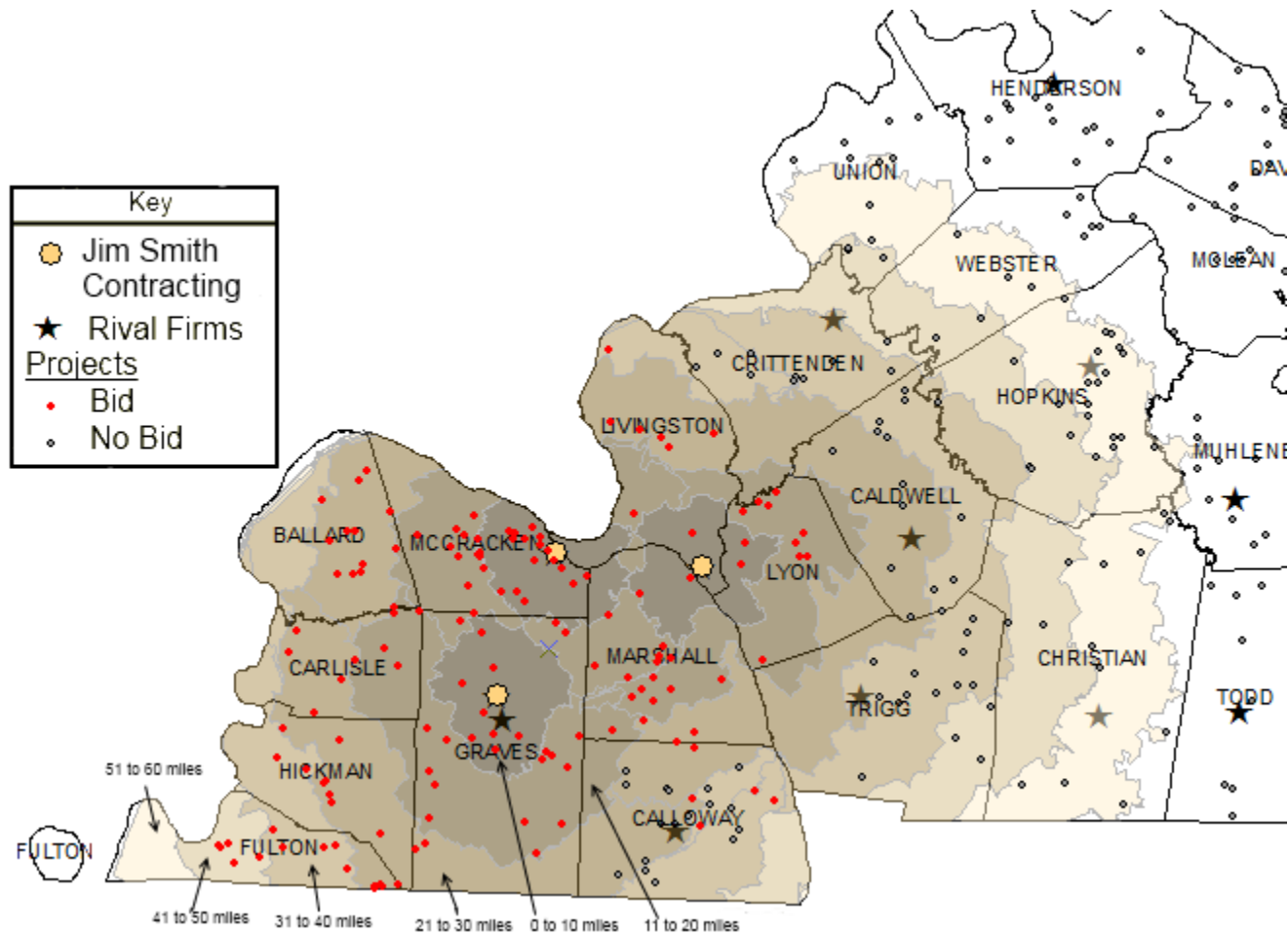


Figure 6.4: Murray Paving Service Area

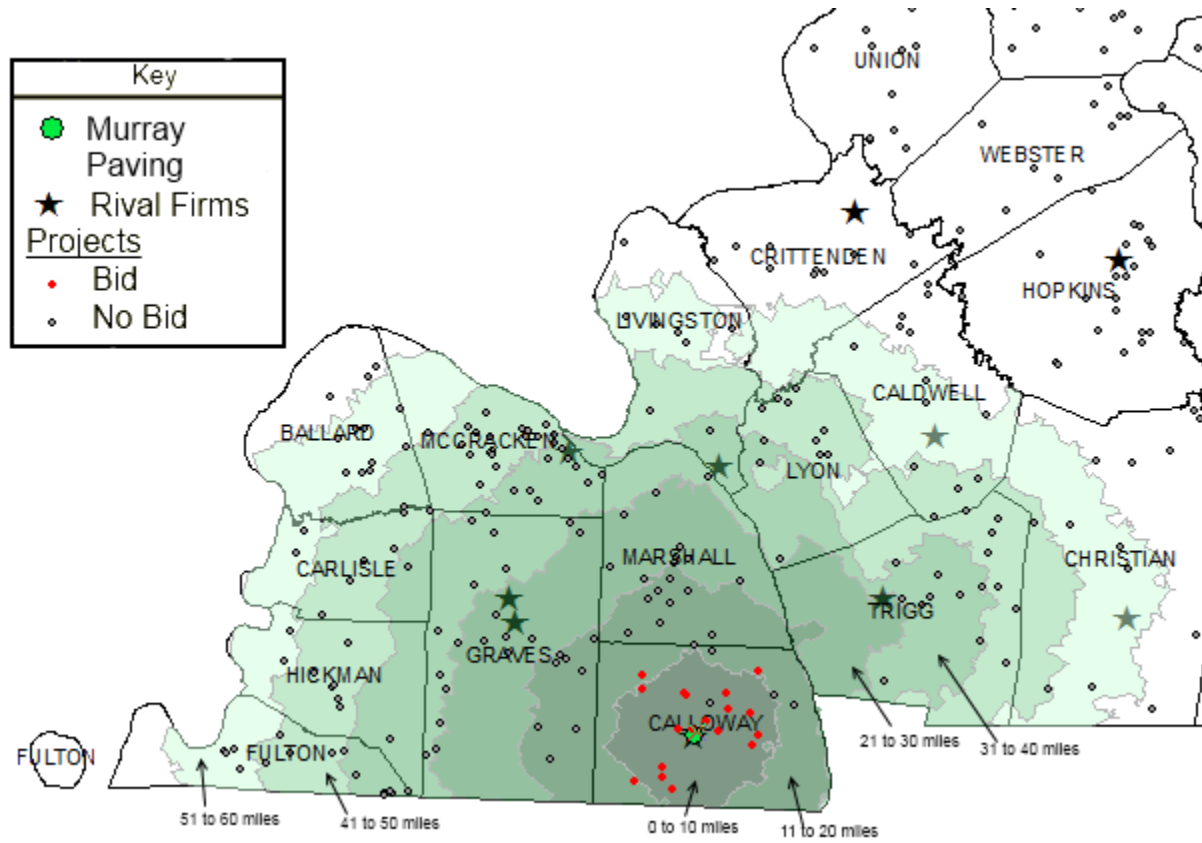
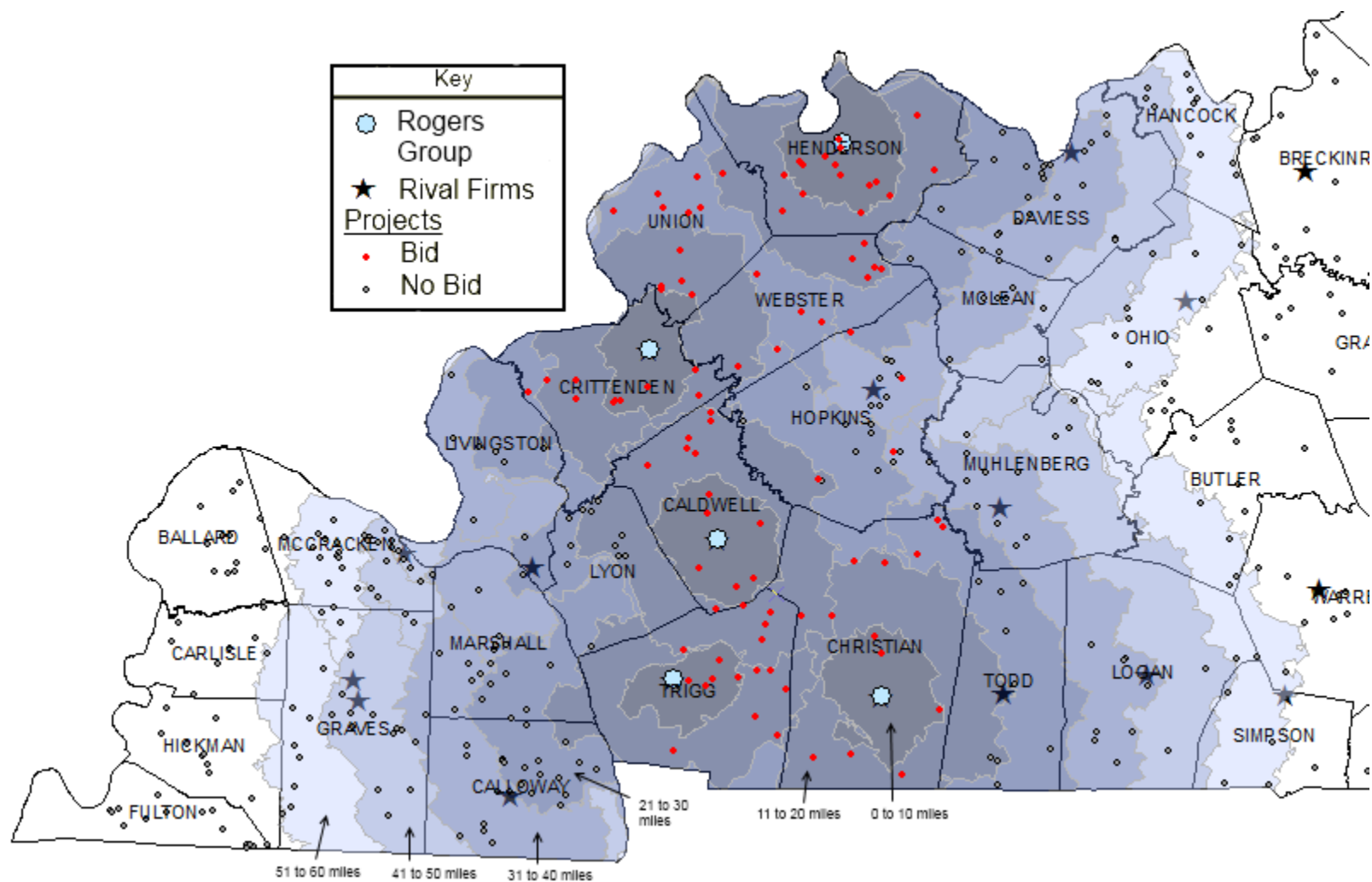


Figure 6.5: Rogers Group Service Area



6.3 District 2 – Western Kentucky

District 2 consists of firms in Western Kentucky (see Figure 6.6). There are four firms that have plants located in this district and that compete on projects: Road Builders & Parkway Construction, Rogers Group, Scotty's Contracting and Stone, and Yager Materials. Jim Smith Contracting, Mago Construction and Qualified Paving have asphalt plants in counties just outside District 2 and are potential competitors on projects. The results that are discussed in this section indicate that Jim Smith Contracting, Mago Construction, Road Builders, Scotty's Contracting, and Yager Materials are tacitly colluding with each in this district specifically in counties where firms have asphalt plants. The most common behavior by firms is to not bid in counties where rival firms have asphalt plants. Table 6.8 summarizes which firms participate in tacit collusion and in the counties where it occurs. Since firms refuse to bid there are a high number of single-bid projects which result in higher bid levels. This lack of bidding is estimated to drive up bids \$8,921,983.04 above the average competitive level. There is no evidence of tacit collusion in Union and Hancock Counties. In Hancock County, the bidding is competitive, and in Union County, there is little evidence of tacit collusion on the part of Road Builders.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data, bid functions, the existence and/or extent of tacit collusion. To aid this discussion summary statistics and result tables are provided in Table 6.8, Table 6.9, Table 6.10, and Table 6.11. A map for each firm follows the tables. The additional regression results found in Table 6.11 only include the county variables, and variations on the county variables are displayed. The other control variables were included in this regression. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.3.1 Firms with Asphalt Plants in District 2

ROAD BUILDERS & PARKWAY CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Road Builders has two plants located in District 2 in Hopkins and Muhlenberg County. Their primary competitors are Rogers Group and Scotty's Contracting. They also compete for projects in McLean County with Yager Materials, and Qualified Paving is a potential competitor who is located in Grayson County. They bid on 38 projects in District 2 and were awarded 34 of the contracts. The contracted value of all of the 38 projects was \$25,933,984.88. The average

number of bidders on these projects was 1.24 bids. Twenty-nine of the 38 bids had one bidder, Road Builders, and the contracted value of these projects was \$22,826,156.48 which averaged 1.17 percent above the engineer's estimate. For the other 9 projects with more than one bidder, the contracted value of the projects average 9.95 percent below the engineer's estimate. The competitive bids are in McLean and Webster Counties. In McLean County, Road Builders bid on five projects and won contracts on four of those projects. Yager Materials bid against Road Builders on two of the five projects. The contracted value of the five projects is 7.55 percent below the engineer's estimate. The bids are competitive. In Webster County, Road Builders bid on seven projects and won three of the projects. Rogers Group also bid on all seven of the projects. The contracted value of the seven projects is 8.97 percent below the engineer's estimate. The fact that there are two bidders puts downward pressure on the bid levels. Looking at the summary statistics in Table 6.9, the projects within 60 miles of the Road Builders plants are distributed relatively similarly across distance rings. Over 60 percent of these projects are located in a county where a rival has an asphalt plant. How Road Builders responds to those rival bidders is explained in the next section.

FIRM BID FUNCTION

The bid function for Road Builders is in Table 6.10. It indicates that once a project gets beyond 30 miles, the probability of Road Builders bidding on a project diminishes significantly. Firms purchasing a bid proposal significantly decrease Road Builders likelihood of bidding on a project. This is not surprising given that 29 of the projects where Road Builders was the lone bidder no other firm purchase a bid proposal. When the county variables are added, a problem arises. There is some multicollinearity between the county variables and the bid proposals variables. There are only a few bid proposals purchased on projects in Hopkins and Muhlenberg Counties, and they are correlated with the county variables.¹¹⁷ The purchase of bid proposals breaks down along county lines and leads to the results where the coefficient on "Project in adjacent county-rival" is positive and not significant (see Table 6.11). Looking at Figure 6.7 it is clear that the county boundaries do influence whether or not Road Builders bids on a project,

¹¹⁷ On project 52140, there were four firms that purchased bid proposals. It was a road rehabilitation project. Road Builders did not purchase a bid proposal or bid on the project. One other project, 62257, had Rogers Group purchasing a bid proposal, bidding, and winning the project. It was an interstate rehabilitation/asphalt paving project. Road Builders did not purchase a bid proposal or bid on the project.

and that they do avoid bidding on projects in adjacent counties with rival firms. The fact there is multicollinearity creates a situation for more reliance on the map and less emphasis on the regression results. There is clearly evidence that Road Builders avoids bidding against rivals and this will be discussed in the specific counties.

ROGERS GROUP

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Rogers Group has three of their five plants located in District 2. Their plants are on the western edge of the district located in Caldwell, Christian and Henderson Counties. Their primary competitors in this district are Road Builders, Scotty's Contracting, and Yager Materials. In Kentucky, Rogers Group bid on 55 projects and were awarded 50 of the contracts. Of those 55 bids, 41 bids were in counties within District 2. The average number of bids on these 41 projects was 1.46. The contracted value of these 41 projects is \$34,271,014.10. Twenty-five of the 41 bids had only Rogers Group as the bidder, and the contracted value of these projects is \$20,972,905.09. All projects in District 2 where only Rogers Group bid average 5.59 percent above the engineer's estimate. When there is more than one bidder on projects Rogers Group bid on this average falls to 4.89 percent below the engineer's estimate. The single-bid contracts awarded to Rogers Group are located in Caldwell, Christian, and Henderson where they have a plant and in Hopkins, Webster and Union Counties.

FIRM BID FUNCTION

The results of the bid function for Rogers Group were discussed in District 1. I will only highlight the variables of interest in this discussion. Distance is a very important determinant of whether Rogers Group bids on a project. They are less likely to bid on projects outside the counties where they have asphalt plants. This effect becomes stronger if a rival firm has an asphalt plant in an adjacent county. As discussed in the District 1 section, there is evidence that Jim Smith Contracting and Rogers Group are tacitly colluding by refusing to bid in each other's territories. According to the additional regression, they also avoid bidding in counties where Road Builders, Scotty's Contracting, and Yager Materials have plants when the other factors are controlled (see Table 6.11). This analysis will be extended to the counties of District 2 in the county-by-county section.

SCOTTY'S CONTRACTING AND STONE

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Scotty's Contracting and Stone has only one of their 12 plants located in District 2. Their plant is on the eastern edge of the district in Ohio County. They also have a plant in Todd County which borders District 2 and can be a potential competitor to projects in Christian County (Rogers Group). Their primary competitors in this district are Road Builders, Rogers Group, and Yager Materials. They bid on 119 projects out of 339 that are within their service area in Kentucky and were awarded 96 of those contracts. Of those 119 bids, 14 bids were in Hancock and Ohio counties within District 2. The average number of bids on these 14 projects was 1.93. The contracted value of these 14 projects is \$21,258,928.83. Scotty's Contracting is the only bidder on eight of the 14 bids and these eight bids have a contracted value of \$20,107,493.11 which averages 6.80 percent below the engineer's estimate. The single-bid contracts awarded to Scotty's Contracting are located in Ohio County where they have a plant. For the other six multi-bid projects in Hancock County, where Scotty's Contracting bid, the contracted value averages 18.64 percent below the engineer's estimate.

FIRM BID FUNCTION

The results of the bid function for Scotty's Contracting can be seen in Table 6.10. The distance variables are significant. Without the county variables, projects more than 20 miles from their asphalt plants start to negatively impact whether they bid on a project. However, when the county variables are added in the second specification (B) the distance variables do not become significant until more than 30 miles. The bid proposal variables are significant and negative. Scotty's Contracting is less likely to bid on a project if another firm has shown a willingness to bid by purchasing a bid proposal. For the county variables, Scotty's Contracting is less likely to bid on a project in a county where they have an asphalt plant and a rival has an asphalt plant than a county where they are the only firm with an asphalt plant. They are also less likely to bid on projects in counties adjacent to the counties where they have asphalt plants. This effect is stronger when a rival firm is in the adjacent county. In Table 6.11, it shows that they are less likely to bid on projects in counties where Mago Construction, Road Builders, Rogers Group, and Yager Materials have plants. They are also less likely to bid on projects in McLean County. Whether this is evidence of tacit collusion will be explored later in each county.

YAGER MATERIALS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Yager Materials has one asphalt plant in District 2 located in Daviess County. Their primary competitors in this district are Mago Construction, Road Builders, Rogers Group, and Scotty's Contracting. Yager Materials bid on 28 projects in District 2 out of 101 that were in its viable service area and were awarded 21 of those contracts. They bid on projects in Daviess, Hancock and McLean Counties. The average number of bids on these 28 projects was 1.57. The contracted value of these 28 projects is \$25,572,066.42. Yager Materials was the only bidder on 19 of the 28 bids. The contracted value of these 19 projects is \$23,809,666.20 which averaged 3.57 percent above the engineer's estimate. This percentage falls to 17.09 percent below the engineer's estimate on the nine projects with two or more bidders.

FIRM BID FUNCTION

The results of the bid function for Yager Materials can be seen in Table 6.10. The distance variables are significant. Without the county variables, they are less likely to bid on projects located greater than 20 miles from their plant. However, when the county variables are added in the second specification the distance is extended beyond 30 miles. The bid proposal variables are significant and negative. Yager Materials is less likely to bid on a project if another firm has shown a willingness to bid by purchasing a bid proposal. Only one of the county variables is significant. The "Project in adjacent county – rival" is significant, meaning they are less likely to bid on projects in an adjacent county where a rival firm has an asphalt plant than on a project in Daviess County. The coefficient for projects in an adjacent county with no rival firms is negative and not significant. This is a reflection of the fact that they bid on projects in Hancock and McLean Counties. In Table 6.11, they are more likely to avoid bidding on projects in counties where Mago Construction, Road Builders, Rogers Group and Scotty's Contracting have asphalt plants. They also avoid bidding on projects in Union and Webster Counties where no firms have asphalt plants, but these counties are at the limits of their service territory. In the next section, the bidding behavior of all the firms is compared to see if tacit collusion is occurring.

6.3.2 Counties in District 2

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and

specific counties without competitors were added (see Table 6.11). In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.10). In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

HANCOCK COUNTY

There are a total of 7 projects in Hancock County. The total contracted value of these projects is \$1,242,081.52. The projects' contracted value average 18.15 percent below the engineer's estimate. The competitive average for District 2 projects is 9.28 percent below the engineer's estimate. There are four competitors who bid on all the projects in these counties: Mago Construction, Qualified Paving, Scotty's Contracting, and Yager Materials. Rogers Group is another potential competitor but does not bid on any projects probably due to the fact that they are so far away from the projects in the county. When the Hancock County variable is added to the Rogers Group additional regression it indicates they are less likely to bid on projects in Hancock County holding all else constant (see Table 6.11). However, they are so far away it does not seem reasonable for them to bid on the projects. What is more interesting is how the multiple bidders drive down the bids substantially. It is interesting that there is so much interest on the projects in Hancock County and multiple firms bid on projects when projects in counties nearby where a firm has an asphalt plant has only one bidder on all the projects (see Daviess and Ohio Counties below). This is a competitive county where Mago Construction, Qualified Paving, Scotty's Contracting, and Yager Materials all actively bid on projects. There is no firm evidence of tacit collusion in this county.

MCLEAN COUNTY

There are a total of nine projects in McLean County. The total contracted value of these projects is \$2,546,159.08 which averages 2.98 percent below the engineer's estimate. Yager

Materials bid on six of the projects and Road Builders bid on five of the projects.¹¹⁸ Out of these nine projects, seven of them have only one bidder. For four of the single-bids it was only Yager Materials, while the other three bids were won by Road Builders. The firms both bid on the other two projects. The single bid projects account for \$2,025,840.38 of the nine projects. They average 0.01 percent below the engineer's estimate. Since there is a threat of competition, there is still some downward pressure on bids. The potential competitors in McLean County are Road Builders, Rogers Group, Scotty's Contracting, and Yager Materials.

The next question is whether there is evidence of tacit collusion. In identifying tacit collusion in a county without an asphalt plant it is important to see if coordination of bids in counties where they firms have plants extend into this county. Firms that are less likely to bid on projects in Daviess County where Yager Materials has their plant include Rogers Group and Scotty's Contracting. These two firms are also less likely to bid on projects in McLean County (see Table 6.11). Looking at Table 6.11, Yager Materials is less likely to bid on projects in counties where Rogers Group and Scotty's Contracting have asphalt plants. There is evidence then that these firms avoid bidding where Yager Materials bids on projects including McLean County.

Road Builders is the other firm that bids on projects in McLean County. Looking at Figure 6.7 and Figure 6.10 there does appear to be a tendency for the firms to bid on projects that are closest to them. Since there are two projects where both firms bid on the projects, it is unclear if the firms are using some geographic boundary to determine where they bid. There is no conclusive evidence that Road Builders is coordinating their bidding with Yager Materials in McLean County though they may be bidding on projects closest to their plants. As stated previously, Rogers Group and Scotty's Contracting avoid bidding in McLean County (see Table 6.11). Road Builders also avoids bidding in counties where Rogers Group and Scotty's Contracting have asphalt plants according to Figure 6.7 (Ohio, Caldwell, etc).

There is evidence of tacit collusion between Yager Materials and Rogers Group and Scotty's Contracting. There is also evidence of tacit collusion between Road Builders and Rogers

¹¹⁸ Of the projects that Yager Materials bid on, two of the projects had multiple components. Project 53227 had three components and project 73226 had two components. This is why there are more than six red dots in Figure 6.10 for Yager Materials. The rest of the projects just had one component.

Group and Scotty's Contracting in McLean County. If these firms actively bid on projects in McLean County it would put downward pressure on the bids. In District 2 multiple-bid projects average 9.28 percent below the engineer's estimate. This would mean that if these firms bid on the single-bid contracts it could result in bids being 9.27 percent lower or \$187,795.40 lower than their current bid levels.

UNION COUNTY

There are a total of seven projects in Union County. The total contracted value of these projects is \$2,823,164.12 (see Table 6.8). The seven projects contracted value averages 5.18 percent above the engineer's estimate. Out of these seven projects, six of them have only one bidder. The other bidder on the one multiple-bid project was J.H. Rudolph of Indiana. However, this firm did not win this project. The one multiple-bid project averaged 0.38 percent below the engineer's estimate.

The Kentucky firms that are potential bidders in Union County include Road Builders and Rogers Group. Union County is on the fringe of the service areas for Yager Materials (see Figure 6.10) and Jim Smith Contracting is in a similar circumstance (see District 1 for their map). These firms are not considered potential competitors because they cannot service all the projects in Union County. Road Builders is closer but does not bid on any projects in Union County (see Figure 6.7). The additional regression results indicate Road Builders is less likely to bid on projects in Union County but it is not statistically significant. While there are problems cited earlier with their regression results, Figure 6.7 seems to indicate that the projects in Union County are beyond the range they normally bid on projects. Road Builders competes with Rogers Group in Webster County, and so the evidence is not entirely conclusive that Road Builders is actually tacitly colluding with Rogers Group in Union County. Rogers Group is more likely to bid in Union County than the counties where they have asphalt plants. Even though Rogers Group is the only Kentucky firm that bids on projects in Union County, Road Builders avoids bidding in Union County for factors other such as distance. The evidence of tacit collusion is very weak in Union County.

WEBSTER COUNTY

There are a total of nine projects in Webster County. The total contracted value of these projects is \$3,334,885.10 (see Table 6.8). The nine projects contracted value averages 6.16

percent below the engineer's estimate. Out of these seven projects, two projects have one bidder. Road Builders and Rogers Group competitively bid on these projects. This competition puts downward pressure on prices when they compete. Yager Materials is the only other firm that could potentially bid on all projects in Webster County. Yager Materials is less likely to bid on projects in Webster County while Rogers Group and Road Builders are more likely to bid on projects in Webster County than they counties where they have asphalt plants (see Table 6.11). Yager Materials is less likely to bid on projects in counties where Rogers Group has an asphalt plant and Rogers Group returns that favor. There is no evidence of collusive agreements between Yager Materials and Road Builders. The two single-bid contracts were bid on by Rogers Group and if Yager Materials bid it would bring down the bid levels. Currently the single-bid contracts are \$96,785.11 above the competitive level and could be lower with competition.

COUNTIES WITH ASPHALT PLANTS

CALDWELL, CHRISTIAN AND HENDERSON COUNTIES

There are 23 projects in Caldwell, Christian and Henderson Counties. Rogers Group has an asphalt plant in all three of these counties. The contracted value of these projects is \$23,621,155.78. The 23 project's contracted value averages 3.27 percent above the engineer's estimate. The average for all projects in District 2 is 0.43 percent below the engineer's estimate. All 14 projects in Caldwell and Christian Counties only had one bidder, Rogers Group. There is only one project in Henderson County that has one bidder. The contracted value of the 15 single-bid contracts in Caldwell, Christian and the one project in Henderson County average 6.02 percent above the engineer's estimate, and the contracted value of the other 8 projects average 1.88 percent below the engineer's estimate.

In Henderson County, Indiana firms E&B Paving and J.H. Rudolph bid on projects. J.H. Rudolph was awarded contracts for two of the projects. The Kentucky firms that are potential competitors in Henderson County include Road Builders and Yager Materials. In Table 6.11 Yager Materials is less likely to bid in counties where Rogers Group has an asphalt plant. The regression is not conclusive for Road Builders, but Figure 6.7 indicates there are projects in Henderson County that are in the same distance ring in other counties where Road Builders bids on projects. This is evidence that Road Builders avoids bidding on projects in Henderson County when they reasonably could. There is evidence of tacit collusion between Rogers Group and

Yager Materials and between Rogers Group and Road Builders. If Yager Materials and Road Builders bid in this county they could put downward pressure on the single-bid contracts and, on average, could drive the bids down to the competitive level (multi-bid average) resulting in lower bids of \$38,664.42.

Rogers Group is the only firm that bids on projects in Caldwell County. Jim Smith Contracting can bid on all projects in Caldwell County and avoids bidding on projects where Rogers Group has an asphalt plant (see Table 6.11). The tacit collusion documented in District 1 between these two firms extends into the counties of District 2. Road Builders is also a potential bidder, and according to Figure 6.7 they do not bid on projects in Caldwell County when they reasonably could. These projects are 6.20 percent above the engineer's estimate. This is 15.48 percent higher than the District 2 average for multi-bid projects, which means the single-bid contracts in Caldwell County are \$817,332.80 above the competitive level for District 2.

In Christian County, Rogers Group has an asphalt plant and the two main competitors are Road Builders and Scotty's Contracting with collusion occurring between Rogers Group and Scotty's Contracting (see Table 6.11). Road Builders also avoids bidding on projects in Christian County. These firms avoid bidding in each other's counties. There are only single-bid contracts in Christian County that average 6.85 percent above the engineer's estimate. If these projects had more competitors it could drive the bids down by about \$1,267,685.72.

The form that tacit collusion takes in these counties is that Jim Smith Contracting, Road Builders, Rogers Group, Scotty's Contracting, and Yager Materials do not bid on projects in Caldwell, Christian and/or Henderson Counties and Rogers Group does not bid in their counties. Even though Henderson County is competitive with firms from Indiana, the other Kentucky firms avoid bidding in this county. In the end, the refusal to bid by these firms leads to single-bid contracts that average above the competitive level.

DAVIESS COUNTY

There are 15 projects in Daviess County where Yager Materials has an asphalt plant. The contracted value of these 15 projects is \$22,704,749.70 which average 3.79 percent above the engineer's estimate. All 15 projects were only bid on by Yager Materials. The firms that can compete in Daviess County are Mago Construction (District 4), Road Builders, Rogers Group, and Scotty's Contracting. In Table 6.11, there is evidence that Rogers Group, Scotty's Contracting

and Mago Construction do not bid on projects in Daviess County and Yager Materials is less likely to bid in counties where these firms have asphalt plants. For Road Builders, they avoid bidding in Daviess County and Yager Materials is less likely to bid on a project in Hopkins and Muhlenberg Counties (see Figure 6.7). There is evidence of tacit collusion between Road Builders and Yager Materials in Daviess County. What is interesting is that Mago Construction, Scotty's Contracting and Yager Materials all bid in Hancock County and they bid against each other. But if the projects are in counties where their competitor has asphalt plants they are less likely to bid on the projects. The maps for these firms show this bidding pattern very clearly (see District 4 for Mago Construction's map). These firms bid on projects in the same distance ring in other counties but not in Daviess County. If the bids averaged at the level that the multi-bid projects do for District 2 then bids would be \$2,967,510.79 lower than their current level.

HOPKINS AND MUHLENBERG COUNTIES

There are 28 projects in Hopkins and Muhlenberg Counties where Road Builders & Parkway Construction have their asphalt plants. The contracted value of these 28 projects is \$26,397,041.70 which average 1.79 percent above the engineer's estimate. Rogers Group bids on two projects in Hopkins County but Road Builders did not bid on those projects.¹¹⁹ Therefore Road Builders is the only bidder on the other 26 projects. The potential competitors that could bid on projects in these counties include Jim Smith Contracting, Rogers Group, Scotty's Contracting, and Yager Materials. However, Jim Smith Contracting cannot bid in Muhlenberg County. In Table 6.11, the coefficient for "Road Builders" in specification "C" is negative and significant for all of these firms. While the regression results for Road Builders are inconclusive, the map of bidding behavior in Figure 6.7 clearly shows that Road Builders avoids bidding on projects where these firms have asphalt plants. Even though Rogers Group bids on two projects in Hopkins County, they do not bid on the other projects and there still is evidence they avoid bidding against Road Builders. There is evidence that of tacit collusion between these firms in Hopkins and Muhlenberg Counties. If the bids averaged at the level that the multi-bid projects

¹¹⁹ One of the projects is asphalt pavement and roadway rehabilitation. The other is resurfacing and rehabilitation on an interstate. Road Builders also bid and won an interstate resurfacing and rehabilitation project. The two interstate projects were let on the same day, November 17, 2006. The other projects in Hopkins County were strictly asphalt resurfacing projects. I could not find a reason why the firms did not bid against each other on these projects or why they bid on the specific projects.

do for District 2 then bids would be \$1,162,539.28 lower than their current level in Hopkins County and \$1,885,004.41 in Muhlenberg County.

OHIO COUNTY

There are 8 projects in Ohio County where Scotty's Contracting and Stone have an asphalt plant. The contracted value of these 8 projects is \$20,107,493.11 which average 6.80 percent below the engineer's estimate. Scotty's Contracting was the only firm that bid on these projects. Looking at Table 6.11, Mago Construction, Qualified Paving, Road Builders, and Yager Materials could all bid on projects in Ohio County. Mago Construction and Yager Materials are all less likely to bid on projects in counties where Scotty's Contracting has an asphalt plant including Ohio County. Looking at the maps for these firms, these firms avoid bidding in Ohio County. For Qualified Paving, there is no indication this firm avoids bidding in Ohio County. What is interesting about Ohio County is how low the contracted value of the projects compared to the engineer's estimate. On three out of the eight projects other firms purchased bid proposals and the contracted value of the bids averaged 15.56 percent below the engineer's estimate. Qualified Paving and Certified Construction of Kentucky are the two firms that purchased bid proposals but did not bid on the projects. The other five projects only average 1.55 percent below the engineer's estimate. The threat of competition from other firms drive down Scotty's Contracting bids. If the Mago Construction, Road Builders, Rogers Group and Yager Materials bid against Scotty's Contracting in Ohio County did, it would put even more downward pressure on the bids. If the bids averaged at the level that the multi-bid projects do for District 2 then bids would be \$498,665.83 lower than their current level.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 2 is Jim Smith Contracting, Mago Construction, Road Builders, Rogers Group, Scotty's Contracting, and Yager Materials all tacitly collude by not bidding in each other's territories. There are two counties where there is no conclusive evidence of tacit collusion: Union and Hancock Counties. When added all together, this avoidance of bidding leads to a large number of single-bid contracts that average \$8,921,983.04 above the multi-bid contracts in District 2.

Table 6.8: Summary of Tacit Collusion for District 2 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Hancock	7	\$ 1,242,081.52	-18.15				No	-	Competitive
McLean	2	\$ 520,318.70	-13.38	7	\$ 2,025,840.38	-0.01	Yes	Four Firms (A)	\$ 187,795.40
Union	1	\$ 699,489.45	-0.38	6	\$ 2,123,674.67	6.11	No	-	Competitive
Webster	7	\$ 2,587,509.70	-8.97	2	\$ 747,375.40	3.67	Yes	Three Firms (B)	\$ 96,785.11
TOTAL (WITHOUT ASPHALT PLANTS)	17	\$ 5,049,399.37	-12.77	15	\$ 4,896,890.45	2.93			
WITH ASPHALT PLANTS									
Caldwell				7	\$ 5,279,923.00	6.20	Yes	Three Firms (C)	\$ 817,332.08
Christian				7	\$ 7,859,179.92	6.85	Yes	Three Firms (D)	\$ 1,267,685.72
Daviess				15	\$ 22,704,749.70	3.79	Yes	Four Firms (E)	\$ 2,967,510.79
Henderson	8	\$ 10,011,109.86	-1.88	1	\$ 470,943.00	-1.07	Yes	Three Firms (B)	\$ 38,664.42
Hopkins				19	\$ 11,071,802.63	1.22	Yes	Five Firms (F)	\$ 1,162,539.28
Muhlenberg				9	\$ 15,325,239.07	3.02	Yes	Four Firms (A)	\$ 1,885,004.41
Ohio				8	\$ 20,107,493.11	-6.80	Yes	Four Firms (E)	\$ 498,665.83
TOTAL (WITH ASPHALT PLANTS)	8	\$ 10,011,109.86	-1.88	66	\$ 82,819,330.43	2.17			
TOTAL (DISTRICT 2)	25	\$ 15,060,509.23	-9.28	81	\$ 87,716,220.88	2.31			\$ 8,921,983.04

(A) These firms include Road Builders, Rogers Group, Scotty's Contracting, and Yager Materials

(B) These firms include Road Builders, Rogers Group and Yager Materials

(C) These firms include Jim Smith Contracting, Road Builders, and Rogers Group

(D) These firms include Road Builders, Rogers Group, and Scotty's Contracting

(E) These firms include Mago Construction, Road Builders, Scotty's Contracting, and Yager Materials

(F) These firms include Jim Smith Contracting, Road Builders, Rogers Group, Scotty's Contracting, and Yager Materials

Table 6.9: Summary Statistics for District 2 Firms

VARIABLES	Road Builders & Parkway Construction		Rogers Group		Scotty's Contracting and Stone		Yager Materials	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.242	0.43	0.284	0.452	0.351	0.478	0.277	0.45
Distance Variables								
Distance (0 to 10 miles) [reference variable]	0.121	0.327	0.0928	0.291	0.109	0.312	0.0990	0.3
Distance (11 to 20 miles)	0.115	0.32	0.129	0.336	0.189	0.392	0.0594	0.238
Distance (21 to 30 miles)	0.140	0.348	0.237	0.426	0.165	0.372	0.158	0.367
Distance (31 to 40 miles)	0.204	0.404	0.237	0.426	0.215	0.412	0.149	0.357
Distance (41 to 50 miles)	0.242	0.43	0.144	0.352	0.186	0.39	0.297	0.459
Distance (51 to 60 miles)	0.178	0.384	0.160	0.367	0.136	0.343	0.238	0.428
Other Control Variables								
Jobs Under Contract	2.497	0.874	3.814	2.332	9.460	4.007	1.337	0.803
Engineer's Estimate	859,417	2.12E+06	751,658	1.88E+06	796,476	1.68E+06	965,784	2.49E+06
Competitive Variables								
Number of Competitor Service Areas	1.465	0.821	1.464	0.735	6.484	2.782	1.663	0.852
Zero other competitive bid proposal purchased [reference variable]	0.185	0.389	0.180	0.386	0.186	0.39	0.0990	0.3
One other competitive bid proposal purchased	0.554	0.499	0.381	0.487	0.437	0.497	0.525	0.502
Two other competitive bid proposals purchased	0.191	0.394	0.351	0.478	0.174	0.38	0.228	0.421
Three or more other competitive bid proposals purchased	0.0701	0.256	0.0876	0.283	0.204	0.403	0.149	0.357
County Variables								
Project in same county-no rival	0.178	0.384	0.191	0.394	0.189	0.392	0.149	0.357
Project in same county-rival	0	-	0	-	0.0531	0.225	0	-
Project in adjacent county-no rival [reference variable]	0.217	0.413	0.227	0.42	0.221	0.416	0.297	0.459
Project in adjacent county-rival	0.605	0.49	0.582	0.494	0.537	0.499	0.554	0.5
Observations	157		194		339		101	

Table 6.10: Regression results for District 2 Firms

VARIABLES	Road Builders & Parkway Construction		Rogers Group		Scotty's Contracting and Stone		Yager Materials	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	0.102 (0.0738)	0.0184 (0.0401)	-0.0895 (0.0739)	-0.0304 (0.0582)	0.0557 (0.0687)	0.0795 (0.0562)	0.0999 (0.0875)	0.132 (0.100)
Distance (21 to 30 miles)	-0.0470 (0.0940)	-0.195 (0.150)	-0.410*** (0.0872)	-0.150 (0.107)	-0.231*** (0.0864)	-0.0201 (0.0886)	-0.349*** (0.112)	-0.196 (0.127)
Distance (31 to 40 miles)	-0.294*** (0.102)	-0.345** (0.136)	-0.554*** (0.0895)	-0.301*** (0.113)	-0.511*** (0.0859)	-0.254*** (0.0913)	-0.789*** (0.109)	-0.507*** (0.176)
Distance (41 to 50 miles)	-0.296*** (0.0997)	-0.374*** (0.134)	-0.633*** (0.0837)	-0.312*** (0.109)	-0.577*** (0.0817)	-0.299*** (0.0878)	-0.894*** (0.0618)	-0.613*** (0.134)
Distance (51 to 60 miles)	-0.302*** (0.100)	-0.338** (0.134)	-0.622*** (0.0831)	-0.317*** (0.111)	-0.595*** (0.0804)	-0.343*** (0.0891)	-0.912*** (0.0623)	-0.654*** (0.129)
Jobs Under Contract	-0.00432 (0.0233)	-0.00628 (0.0212)	0.00127 (0.00757)	0.000431 (0.00615)	0.00296 (0.00412)	0.00241 (0.00367)	-0.0300 (0.0264)	-0.0217 (0.0246)
Engineer's Estimate	-3.72e-09 (5.05e-09)	7.60e-10 (3.25e-09)	1.90e-08*** (6.17e-09)	2.15e-08*** (6.13e-09)	-8.54e-09 (1.12e-08)	-8.54e-09 (7.60e-09)	-6.52e-09 (1.36e-08)	-4.36e-09 (1.05e-08)
Potential Competitors	-0.00961 (0.0118)	-0.00234 (0.0130)	-0.0832*** (0.0201)	-0.0778*** (0.0161)	-0.0134*** (0.00506)	-0.00315 (0.00393)	-0.00310 (0.0194)	0.0106 (0.0183)
One competitive bid proposal purchased	-0.696*** (0.0963)	-0.803*** (0.0976)	-0.458*** (0.0857)	-0.287*** (0.0945)	-0.419*** (0.0607)	-0.238*** (0.0469)	-0.274** (0.109)	-0.212** (0.0993)
Two competitive bid proposals purchased	-0.659*** (0.105)	-0.809*** (0.0989)	-0.496*** (0.0844)	-0.351*** (0.0911)	-0.373*** (0.0744)	-0.251*** (0.0580)	-0.197* (0.116)	-0.185* (0.105)
Three or more competitive bid proposals purchased	-0.736*** (0.0986)	-0.834*** (0.0942)	-0.540*** (0.0885)	-0.379*** (0.0978)	-0.366*** (0.0670)	-0.160*** (0.0500)	-0.355*** (0.119)	-0.263** (0.103)
Project in same county-rival						-0.181* (0.108)		
Project in adjacent county-no rival		0.328** (0.152)		-0.204* (0.107)		-0.189*** (0.0625)		-0.106 (0.105)
Project in adjacent county-rival		0.141 (0.165)		-0.474*** (0.123)		-0.544*** (0.0708)		-0.329** (0.130)
Constant	1.043*** (0.0782)	1.016*** (0.0766)	1.453*** (0.102)	1.398*** (0.0827)	1.065*** (0.0582)	1.024*** (0.0426)	1.229*** (0.142)	1.100*** (0.130)
Observations	157	157	194	194	339	339	101	101
R-squared	0.793	0.825	0.734	0.797	0.652	0.740	0.770	0.805

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.11: Additional regression results for District 2 firms and firms outside of District 2

VARIABLES	Road Builders & Parkway Construction			Rogers Group			Scotty's Contracting and Stone			Yager Materials		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival							-0.181*	-0.166	-0.218*			
							(0.108)	(0.112)	(0.114)			
Project in adjacent county-no rival	0.328**	0.329**		-0.204*	-0.192**		-0.189***	-0.0616		-0.106	-0.107	
	(0.152)	(0.152)		(0.107)	(0.0953)		(0.0625)	(0.0731)		(0.105)	(0.0948)	
Project in adjacent county-rival	0.141		-0.274	-0.474***		-0.421***	-0.544***		-0.648***	-0.329**		-0.721***
	(0.165)		(0.171)	(0.123)		(0.124)	(0.0708)		(0.106)	(0.130)		(0.174)
Project in adjacent county-Jim Smith		0.174			-0.416***							
		(0.162)			(0.111)							
Project in adjacent county-Mago Construction								-0.248**			-0.346**	
								(0.0986)			(0.134)	
Project in adjacent county-Qualified Paving		0.0913									0.213	
		(0.0559)									(0.149)	
Project in adjacent county-Road Builders					-0.461***			-0.347***			-0.213*	
					(0.146)			(0.0913)			(0.109)	
Project in adjacent county-Rogers Group		0.123						-0.427***			-0.408**	
		(0.169)						(0.0955)			(0.173)	
Project in adjacent county-Scotty's Contracting		0.111			-0.616***						-0.504***	
		(0.168)			(0.130)						(0.155)	
Project in adjacent county-Yager Materials		0.213			-0.322***			-0.538***				
		(0.161)			(0.109)			(0.0960)				
Project in Hancock County						-0.392***			0.177			0.212
						(0.130)			(0.170)			(0.145)
Project in McLean County			-0.0129			-0.377***			-0.711***			-0.225
			(0.209)			(0.129)			(0.112)			(0.243)
Project in Union County			-0.274			0.194**						-0.704***
			(0.175)			(0.0912)						(0.181)
Project in Webster County			0.588***			0.471***			-0.632***			-0.727***
			(0.190)			(0.114)			(0.108)			(0.169)
Constant	1.016***	1.076***	1.093***	1.398***	1.510***	1.181***	1.024***	1.065***	0.960***	1.100***	1.125***	1.153***
	(0.0766)	(0.0927)	(0.0744)	(0.0827)	(0.0982)	(0.0580)	(0.0426)	(0.0506)	(0.0340)	(0.130)	(0.229)	(0.118)
Observations	157	157	157	194	194	194	339	339	339	101	101	101
R-squared	0.825	0.827	0.901	0.797	0.812	0.926	0.740	0.749	0.849	0.805	0.823	0.916

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.11 (continued)

VARIABLES	Jim Smith Contracting			Mago Construction			Qualified Paving		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	-0.0254 (0.0268)	-0.0471** (0.0217)	0.0273 (0.0202)	0.182** (0.0715)	0.143* (0.0767)	0.423*** (0.0733)			
Project in adjacent county-no rival	-0.0377 (0.0308)	-0.0342 (0.0213)		-0.380*** (0.0842)	-0.296*** (0.0842)		-0.330 (0.226)	-0.0127 (0.123)	
Project in adjacent county-rival	-0.624*** (0.0966)		-1.008*** (0.0624)	-0.527*** (0.0793)		-0.364*** (0.0605)	-0.401* (0.234)		-0.207 (0.225)
Project in adjacent county-Jim Smith									
Project in adjacent county-Mago Construction							0.127 (0.144)		
Project in adjacent county-Qualified Paving					-0.00956 (0.0250)				
Project in adjacent county-Road Builders		-0.688*** (0.115)			-0.381*** (0.0860)		-0.0748 (0.111)		
Project in adjacent county-Rogers Group		-0.885*** (0.0751)			-0.361*** (0.0828)				
Project in adjacent county-Scotty's Contracting					-0.412*** (0.0833)		-0.115 (0.0959)		
Project in adjacent county-Yager Materials					-0.376*** (0.0822)		-0.0240 (0.115)		
Project in Hancock County						0.425*** (0.141)			-0.0858 (0.272)
Project in McLean County						-0.356*** (0.0613)			-0.161 (0.232)
Project in Union County			-1.142*** (0.141)						
Project in Webster County			-1.207*** (0.134)						
Constant	1.332*** (0.131)	1.130*** (0.0810)	1.042*** (0.0873)	1.278*** (0.0735)	1.264*** (0.0818)	1.227*** (0.0737)	0.712*** (0.203)	0.773*** (0.228)	0.711*** (0.206)
Observations	141	141	141	570	570	570	131	131	131
R-squared	0.796	0.885	0.912	0.692	0.710	0.773	0.345	0.376	0.386

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.6: District 2

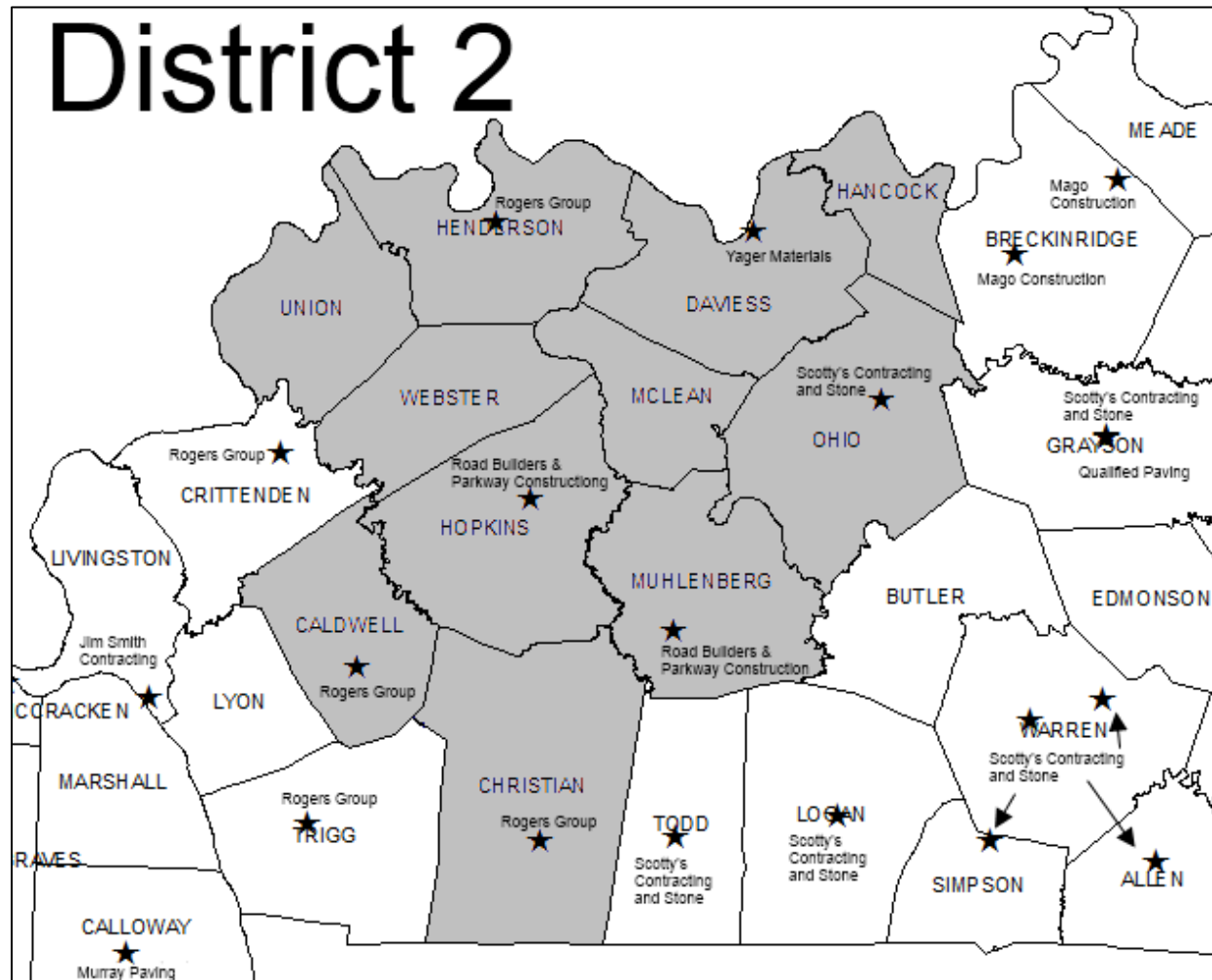


Figure 6.7: Road Builders & Parkway Construction Service Area

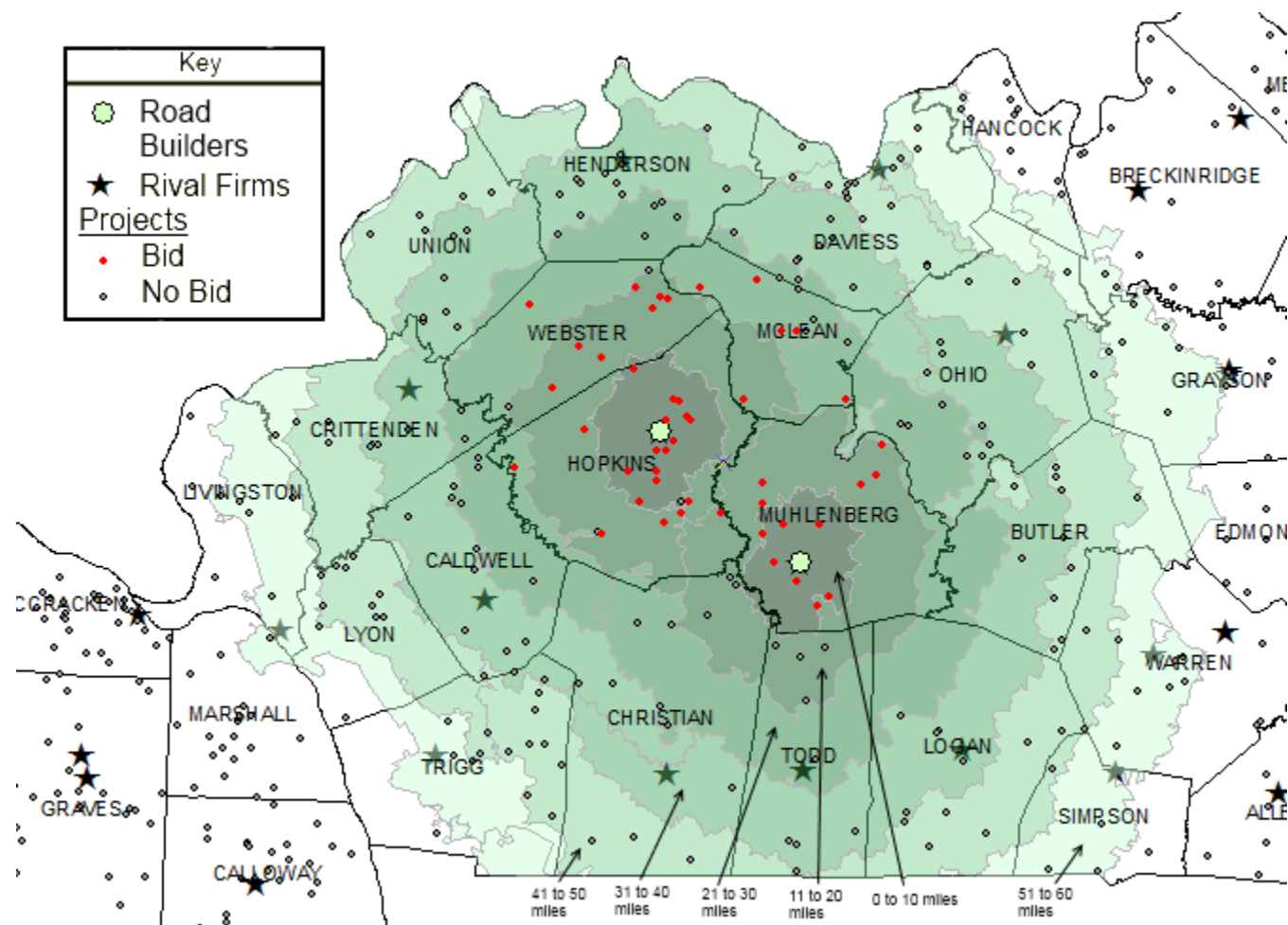


Figure 6.8: Rogers Group Service Area

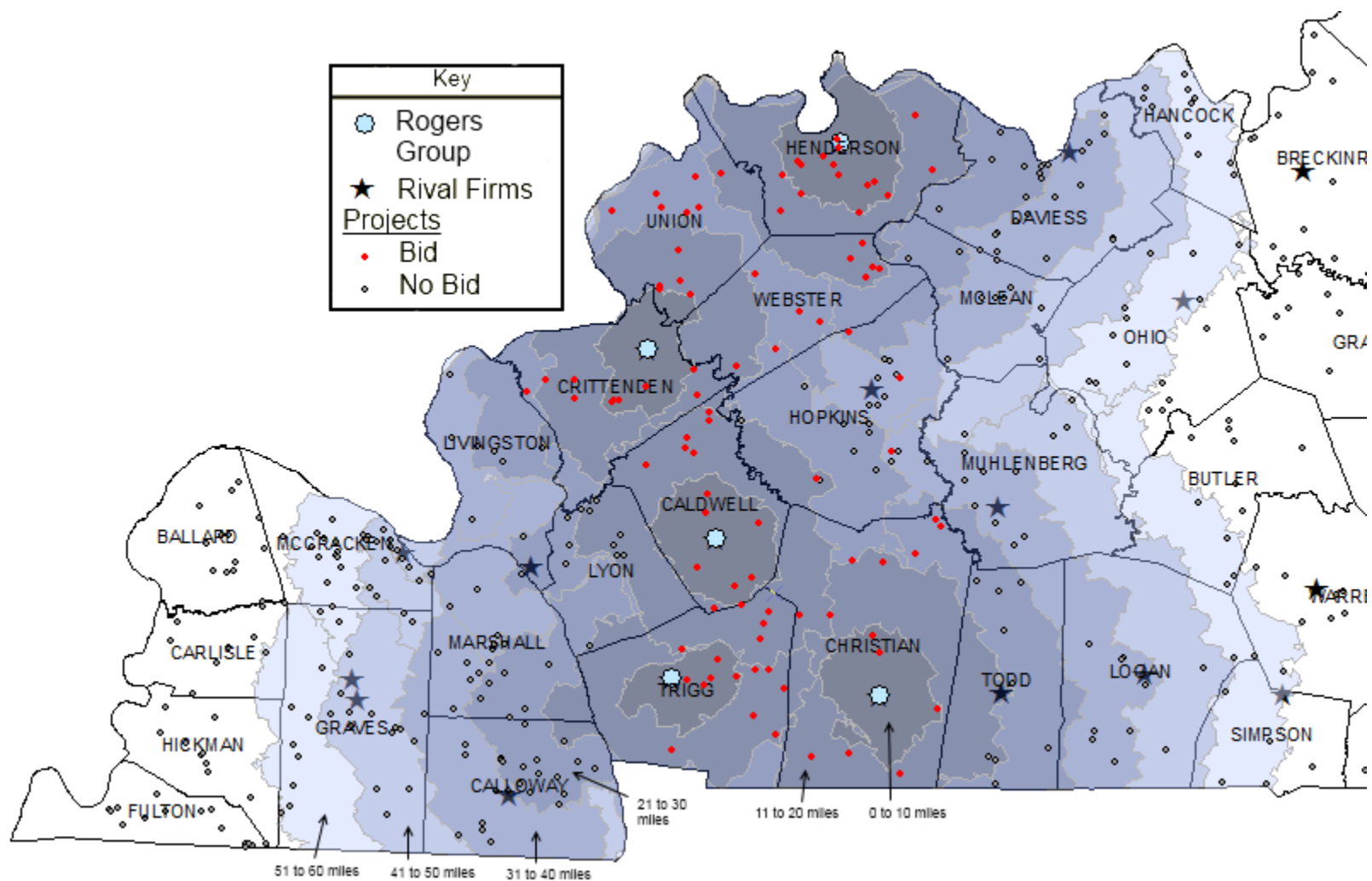


Figure 6.9: Scotty's Contracting and Stone Service Area

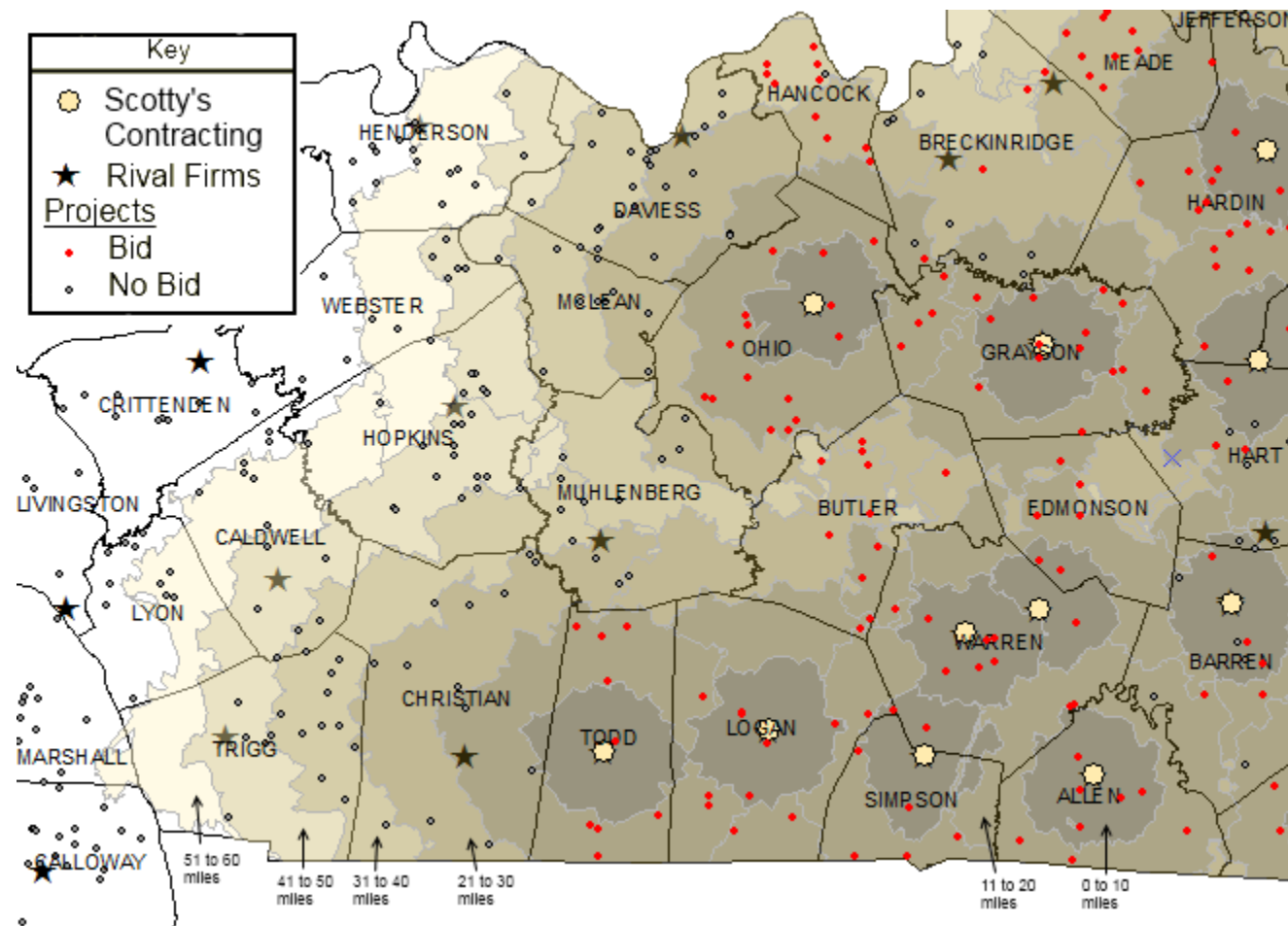
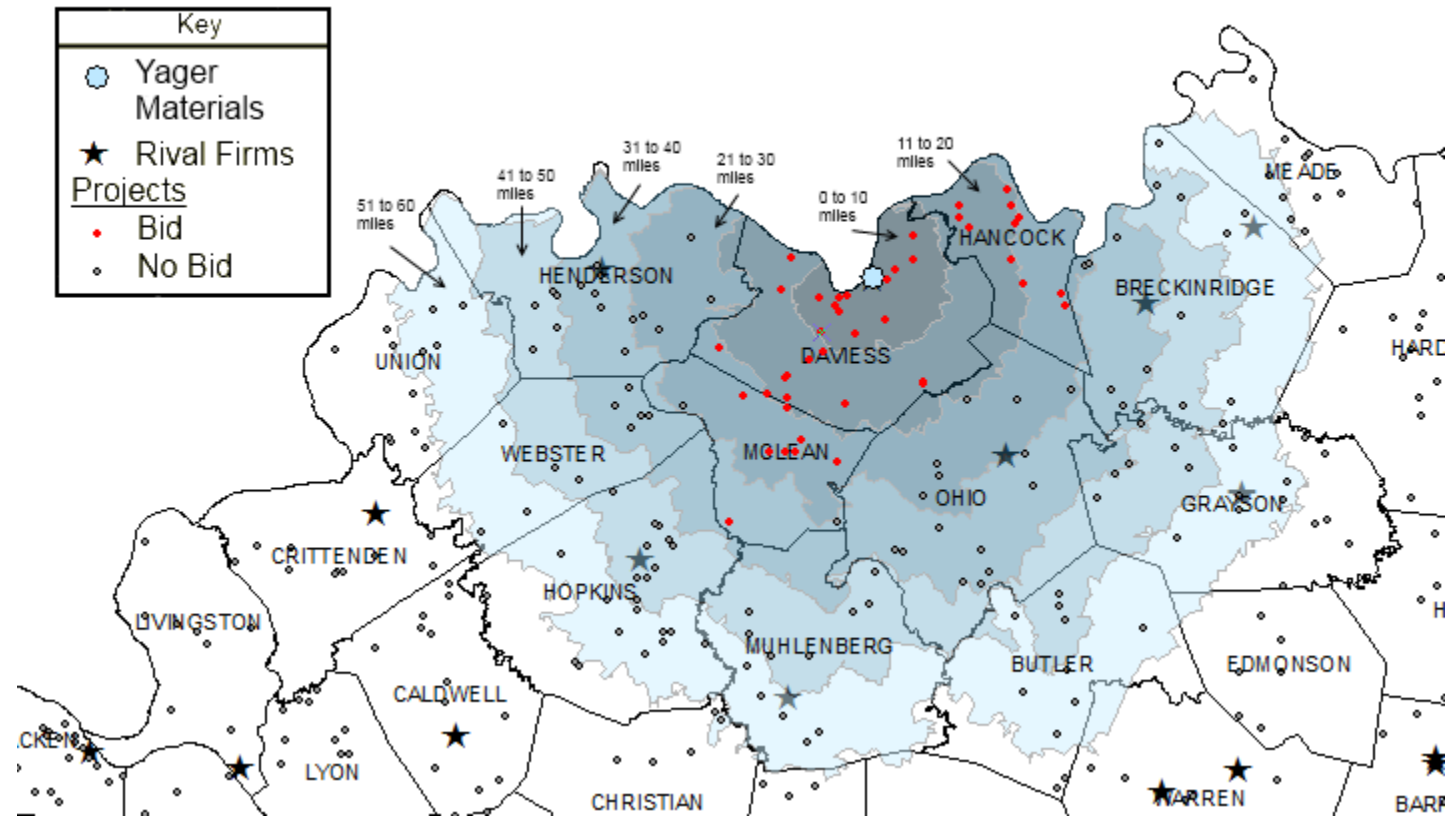


Figure 6.10: Yager Materials Service Area



6.4 District 3 – Western Kentucky

District 3 consists of firms in southwestern Kentucky (see Figure 6.11). There are two firms that have plants located in this district and that compete on projects: Glass Paving and Scotty's Contracting and Stone. Gaddie-Shamrock, Nally & Haydon Surfacing, Qualified Paving, Road Builders & Parkway Construction, and Rogers Group have asphalt plants in counties just outside District 3 and are potential competitors on projects. The results indicate that firms are tacitly colluding in each county of the district. This is specifically true with Glass Paving and Scotty's Contracting. There is even evidence that these two firms had a period of retaliation where Glass Paving retaliated against Scotty's Contracting by bidding in counties they normally do not bid in. This is detailed in full in the "Counties" section. There is also evidence that Rogers Group and Scotty's Contracting are tacitly colluding as well as Road Builders and Scotty's Contracting. Gaddie-Shamrock and Nally & Haydon Surfacing avoid bidding in Metcalfe County and there is evidence this is a result of tacit collusion. The tacit collusion between Glass Paving and Scotty's Contracting along with the other tacit collusion results in bids being approximately \$5,067,574.59 above the competitive level.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.12, Table 6.13, Table 6.14, and Table 6.15. A map for the two firms follows the tables. The additional regression results found in Table 6.15 only includes the county variables. The other control variables were included in this regression but not displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.4.1 Firms with Asphalt Plants in District 3

GLASS PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Glass Paving has one asphalt plant located in District 3 in Barren County where Scotty's Contracting also has an asphalt plant. Their primary competitors are Nally & Haydon Surfacing (District 4) and Scotty's Contracting. They bid on 11 projects in District 3 and were awarded seven of the contracts. The contracted value of all of the 11 projects was \$8,456,697.75. The average number of bidders on these projects was 1.45 bids. Six of the 11 bids only had one

bidder, Glass Paving, and the contracted value of these projects was \$5,765,683.55. The contracted value of these six single-bid contracts averaged 0.10 percent above the engineer's estimate. For the other five projects with more than one bidder, the contracted value of the projects averages 10.05 percent below the engineer's estimate. That is a difference of 10.15 percent with the addition of competitors. The competitive bids are located in Barren, Edmonson, Metcalfe and Monroe Counties with Scotty's Contracting winning four of those bids.

FIRM BID FUNCTION

The bid function for Glass Paving is in Table 6.14. Without the county variables (A), it indicates that once a project gets beyond 20 miles, the probability of Glass Paving bidding on a project diminishes significantly. However, when the county variables (B) are added the distance variables are no longer significant. In the first specification the number of jobs under contract is positive and the bid proposal variables are negative. However, this does not hold up in the second specification (B). The primary thing that is motivating Glass Paving is whether or not the project is located in a county where they have an asphalt plant. They are less likely to bid on projects in those counties outside Barren and Hart (District 4) Counties where they have their asphalt plants. Looking at the additional regressions in Table 6.15, when distance and the other factors are controlled they are less likely to bid in counties where Gaddie-Shamrock, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting has asphalt plants compared to counties where they have their plants. More of their bidding behavior will be explored in the "Counties" section.

SCOTTY'S CONTRACTING AND STONE

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Scotty's Contracting and Stone has eight of their 12 plants located in District 3. Their plants are in all but three of the counties (Butler, Edmonson and Metcalfe). They have a number of competitors in District 3 including Gaddie-Shamrock, Glass Paving, Nally & Haydon Surfacing, Qualified Paving, Rogers Group and Road Builders & Parkway Construction. Only Glass Paving has a plant located in District 3 in Barren County. They bid on 119 projects in Kentucky and were awarded 96 of those contracts. Of those 119 bids, 67 bids were in the ten counties within District 3. The average number of bids on these 67 projects was 1.16. The contracted value of these 67 projects is \$36,180,320.38. Scotty's Contracting was the only bidder on 56 of the 67 bids, and these 56 bids have a contracted value of \$31,779,791.74. The 56 project's contracted

value averages 1.07 percent below the engineer's estimate. For the other 11 multi-bid projects Scotty's Contracting bid on, the contracted value averages 14.64 percent below the engineer's estimate. This is a difference of 13.57 percent which represents how much competition drives down bids. Whether there is evidence of tacit collusion will be explored in the next sections.

FIRM BID FUNCTION

The results of the bid function for Scotty's Contracting were discussed in detail in the District 2 section. The important points of the bid function will be highlighted here. Distance is an important factor that influences whether they bid on a project. All three of the county variables are significant and negative. This means they are less likely to bid on projects outside the counties where they have their asphalt plants with no other firms in the county. The magnitude gets larger for the adjacent county and is largest when an adjacent county has a rival firm in the county. Scotty's Contracting has 12 plants located in multiple districts. The majority of their plants are located in District 3. The analysis in this section will only focus on their bidding behavior and their rivals bidding behavior in District 3. Analysis of the District 2 and 4 are contained in their respective sections.

6.4.2 Counties in District 3

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.15). In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.14). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

BUTLER COUNTY

There are a total of five projects in Butler County.¹²⁰ The total contracted value of these projects is \$2,615,859.70. The project's contracted value averages 7.37 percent below the engineer's estimate. The average for all of District 3 projects is 3.06 percent below the engineer's estimate (see Table 6.12). There are two firms that bid on some of the projects in these counties: Qualified Paving (District 4) and Scotty's Contracting. Scotty's Contracting bids on all of the projects while Qualified Paving bids on two of them. The two bids with two competitors' averages 24.34 percent below the engineer's estimate while the three bids with only Scotty's Contracting as the bidder averages 3.94 above the engineer's estimate. The other potential competitors for all of the projects in Butler County include Road Builders. This firm has all of the projects in Butler County within their 60 mile service area. According to the additional regression for Road Builders, they are less likely to bid on projects in Butler County but not at a significant level. However, according to Road Builders map, they could bid on the projects in Butler County, but they do not (see Figure 6.7). Scotty's Contracting avoids bidding against Road Builders (see Table 6.15). The same analysis is applied to Qualified Paving and Scotty's Contracting. There is evidence of tacit collusion in Butler County where Road Builders avoids bidding on projects in Butler County and Scotty's Contracting avoids bidding in Hopkins and Muhlenberg Counties. This means that the single-bid contracts are \$363,210.33 above where they would be in a competitive situation if Road Builders bid on the projects in Butler County.

EDMONSON COUNTY

There are a total of six projects in Edmonson County.¹²¹ The total contracted value of these projects is \$1,652,985.13 which average 14.17 percent below the engineer's estimate. Out of the six projects, two only have one bidder. Scotty's Contracting is the lone bidder on the two projects. Glass Paving and Qualified Paving are other major competitors that bid on projects.

¹²⁰ While there are projects in Butler County, these five projects have multiple components. Projects 53304, 63308, and 73129 have four components each. This explains why there are more than five dots in Butler County.

¹²¹ Looking at Figure 6.13 there appears to only be four dots in Edmonson County. However there are two projects that are right near the border. These two projects are in Edmonson County even though they may appear in other counties. This is due to the scaling of the mapping software.

Glass Paving's one bid in Edmonson County will be analyzed later on. The single-bid projects average 14.61 percent below the engineer's estimate. Since there is a threat of competition from Qualified Paving, there is downward pressure on bids.

The next question is whether there is evidence of tacit collusion. The three major firms that bid on projects in Edmonson County are Glass Paving, Qualified Paving and Scotty's Contracting. These are the only potential competitors. Glass Paving is less likely to bid on projects in Edmonson County even though they bid on the one project. Scotty's Contracting is less likely to bid on a project where Glass Paving has an asphalt plants (see Table 6.15). Even though Glass Paving bids in Edmonson, there is still evidence they are tacitly colluding with Scotty's Contracting. There is no evidence of tacit collusion between Qualified Paving and Scotty's Contracting or Qualified Paving and Glass Paving. There is evidence of tacit collusion, but the single-bid contracts average below the competitive average for multi-bid projects.

METCALFE COUNTY

There are a total of 10 projects in Metcalfe County. The total contracted value of these projects is \$4,033,410.99 which averages 1.81 percent above the engineer's estimate (see Table 6.12). Out of these 10 projects, nine of them have only one bidder, Scotty's Contracting. Glass Paving is the other firm that bid on one of the projects. The one multiple-bid project averaged 7.36 percent below the engineer's estimate. In the additional regressions in Table 6.15, the "Metcalfe County" coefficients show that Glass Paving, Gaddie-Shamrock, and Nally & Haydon Surfacing are less likely to bid on projects in Metcalfe County. The firms avoid bidding against Scotty's Contracting. In turn Scotty's Contracting avoids bidding on projects in counties where they have asphalt plants and bid.

These results support the case for tacit collusion in Metcalfe County. While Glass Paving does bid in Metcalfe County they only do it on one project and they do not even purchase a bid proposal on any other projects. Looking at Figure 6.12 for Glass Paving, the projects in Metcalfe County are within a distance ring where they bid on projects in Hart County (District 4). Essentially, Scotty's Contracting is allowed to be the only bidder in the county. This is further supported by the lack of bidding by Nally & Haydon Surfacing and Gaddie-Shamrock who have plants located in counties directly adjacent to Metcalfe County. Except for that one bid by Glass Paving, there is clear evidence that firms allow Scotty's Contracting to be the lone bidder in

Metcalfe County.

Besides this one bid in Metcalfe County, Glass Paving only bids on one project in Edmonson and Monroe Counties also. Digging into the bids some interesting things stand out. As is documented in this section, there is evidence of tacit collusion between Glass Paving and Scotty's Contracting. The first deviation by Scotty's Contracting occurred on May 26, 2006 when they bid on a project in Barren County where Glass Paving has been the primary bidder. They followed that up by again bidding in Barren County and Hart County on July 21, 2006. Both these counties are primarily Glass Paving territory. The next bidding cycle on August 11, 2006, Glass Paving retaliated and bid on projects in Edmonson, Metcalfe and Monroe Counties where Scotty's Contracting is the primary bidder. The bidding went back to "normal" after that. Not only are the firms tacitly colluding, but there is also a great example of how the collusive behavior is maintained by what appears to be a retaliatory bid by Glass Paving in three counties where Scotty's Contracting is the primary bidder. The bidding behavior in these other counties is discussed in their respective sections. The financial impact of this tacit collusion in Metcalfe County results in single-bid contracts that are 16.19 percent above the multi-bid average for District 3. This means that bids are \$618,571.91 above where they would be in a competitive situation. The impact of tacit collusion in the other counties will be discussed in the next sections.

COUNTIES WITH ASPHALT PLANTS

ALLEN, LOGAN, MONROE, SIMPSON, TODD AND WARREN COUNTIES

In these six counties, Scotty's Contracting is the only firm that has asphalt plants. There are 44 projects in these counties. The contracted value of these projects is \$26,691,136.66 which averages 2.00 percent below the engineer's estimate. The competitive average for projects in District 3 is 14.64 percent below the engineer's estimate. There are a total of 42 projects that have only one bidder and in every case that bidder is Scotty's Contracting. The contracted value of the 42 single-bid contracts averages 1.62 percent below the engineer's estimate, and the contracted value of the other two projects average 10.10 percent below the engineer's estimate.

In Allen County, of the six projects only one of them has another bidder who bids against Scotty's Contracting.¹²² Besides Scotty's Contracting, the potential competitors for projects in Allen County include only Glass Paving. As discussed earlier, there is evidence that Scotty's Contracting and Glass Paving tacitly collude. It is a pattern that is repeated throughout the counties in District 3. The impact of the tacit collusion between these two firms is that bids are \$346,350.62 above where they would be in a competitive situation.

Scotty's Contracting is the only bidder on the projects in Logan County. Road Builders and Rogers Group are potential competitors in Logan County. Both Glass Paving and Qualified Paving have only part of their 60 mile service area that is in Logan County and are not potential competitors. As discussed in District 2, there is evidence of tacit collusion between Road Builders and Scotty's Contracting (see Figure 6.7 and Figure 6.13). Road Builders could reasonably bid in Logan County, but does not. There is strong evidence of tacit collusion between Scotty's Contracting and Rogers Group. The impact of the tacit collusion between these two firms is that bids are \$508,835.14 above where they would be in a competitive situation.

In Monroe County, there is one bid that Glass Paving bids on, and Scotty's Contracting bids on all of the projects. Both Gaddie-Shamrock and Nally & Haydon Surfacing are potential bidders but do not bid on projects in Monroe County. The reasons for the one bid by Glass Paving were discussed previously. According to the additional regressions, neither Gaddie-Shamrock nor Nally & Haydon Surfacing is less likely to bid against Scotty's Contracting. This means there is no evidence of tacit collusion between these firms and Scotty's Contracting in Monroe County. Another factor, such as distance, explains why these firms do not bid on projects where Scotty's Contracting has an asphalt plant. There is evidence for tacit collusion between Glass Paving and Scotty's Contracting. The financial impact is that the bids are 14.19 percent higher than the multi-bid projects. This results in bid levels that are \$362,831.20 higher than the competitive level.

¹²² The firm is Kenway Paving based out of Bowling Green in Warren County. They are not one of the 31 major firms due to lack of bids and unavailability of information for them.

In Simpson County, there are no other competitors that can reasonably bid on all of the projects in Simpson County. Most of the projects in Simpson County are more than 40 to 60 miles away from Glass Paving, Road Builders and Rogers Group asphalt plants. This leaves just Scotty's Contracting as the only reasonable bidder on all of the projects in Simpson County.

In Todd County, both Rogers Group (Christian) and Road Builders (Muhlenberg) are within reasonable distance to bid on all projects. As has been shown in previous counties, Rogers Group avoids bidding in counties where Scotty's Contracting has an asphalt plant. Scotty's Contracting also avoids bidding in Christian County where Rogers Group has an asphalt plant. On the Scotty's Contracting map (see Figure 6.13) it is interesting to see that the county boundary of Todd County is definitely a border they do not cross to bid. There is clear evidence of tacit collusion between these two firms. Figure 6.7 and Figure 6.9 show that Road Builders and Scotty Contracting do not bid in each other's counties. This is evidence of tacit collusion, because of the issues with the regressions for Road Builders discussed in District 2. The bids average 13.90 percent or \$278,931.63 above the multi-bid project bid levels due to the coordination of bids.

In Warren County, the potential competitors are Glass Paving and Scotty's Contracting. The other potential competitors include Qualified Paving whose whole service area covers all of Warren County. There is evidence of tacit collusion only between Scotty's Contracting and Glass Paving. Bids are 12.11 percent above the multi-bid projects average or \$1,738,982.01 above the competitive bid level.

BARREN COUNTY

There are eight projects in Barren County where Glass Paving and Scotty's Contracting have their asphalt plants. Glass Paving bid on all of the projects and won seven of the projects. Scotty's Contracting only bid on two projects in Barren County on May 26, 2006 and July 21, 2006. As discussed earlier, it appears that from May 2006 through August 2006, Glass Paving and Scotty's Contracting had a bidding war where they bid on projects in areas they typically do not bid. It could have originated with the May 26, 2006 bid in Barren County where Scotty's Contracting outbid Glass Paving and won the project. When Scotty's Contracting followed up on July 21, 2006 with another bid in Barren County and a bid in Hart County, it appears that is when Glass Paving retaliated and bid on the projects in Edmonson, Metcalfe and Monroe Counties on August 11, 2006. Any way you look at it, the behavior by Scotty's Contracting and Glass Paving

indicate they maintain their agreement through retaliatory bidding. Also, Nally & Haydon Surfacing and Gaddie-Shamrock are potential bidders that could bid on all projects in Barren County but they do not. There is no evidence of tacit collusion between Gaddie-Shamrock, Nally & Haydon Surfacing and Scotty's Contracting. There is evidence of tacit collusion between Glass Paving and Nally & Haydon Surfacing. They both are less likely to bid in counties where the other firm has an asphalt plant. There is evidence of tacit collusion between Scotty's Contracting and Glass Paving along with tacit collusion between Glass Paving and Nally & Haydon Surfacing (see Table 6.15). The single-bid contracts are 14.74 percent or \$849,861.76 above the competitive level.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 3 is both fascinating and intriguing. There is evidence that Glass Paving and Scotty's Contracting are engaging in tacitly collusive behavior and it is being maintained through retaliation. When Scotty's Contracting cheated and bid where they were not "supposed" to bid, Glass Paving retaliated in Edmonson, Metcalfe and Monroe Counties and then the bidding went back to the previous collusive behavior. Nally & Haydon and Gaddie-Shamrock also refuse to bid in Metcalfe County even though they reasonably could. On the other side of the district, Rogers Group does not bid in Todd County and Scotty's Contracting does not bid in Christian County. These are a few examples of the type of tacit collusion found in District 3. The tacit collusion in District 3 results in bids that are \$5,067,574.59 above the competitive level. There is no evidence of tacit collusion in Simpson County, because Scotty's Contracting is the only reasonable bidder on all of the projects.

Table 6.12: Summary of Tacit Collusion for District 3 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Butler	2	\$ 661,014.00	-24.34	3	\$ 1,954,845.70	3.94	Yes	Two Firms (A)	\$ 363,210.33
Edmonson	4	\$ 1,498,208.84	-13.95	2	\$ 154,776.29	-14.61	Yes	Two Firms (B)	Competitive
Metcalfe	1	\$ 492,644.50	-7.36	9	\$ 3,540,766.49	2.83	Yes	Four Firms (C)	\$ 618,571.91
TOTAL (WITHOUT ASPHALT I	7	\$ 2,651,867.34	-15.98	14	\$5,650,388.48	0.58			
WITH ASPHALT PLANTS									
Allen	1	\$ 115,421.10	-10.87	5	\$ 1,950,172.40	3.12	Yes	Two Firms (B)	\$ 346,350.62
Barren	2	\$ 1,186,927.90	-14.50	6	\$ 5,765,683.55	0.10	Yes	Three Firms (D)	\$ 849,861.76
Logan				8	\$ 4,016,062.70	-1.97	Yes	Three Firms (E)	\$ 508,835.14
Monroe	1	\$ 446,312.30	-9.34	6	\$ 2,556,949.99	-0.45	Yes	Two Firms (B)	\$ 362,831.20
Simpson				5	\$ 1,239,631.39	-6.07	No	One Firm	
Todd				6	\$ 2,006,702.34	-0.74	Yes	Three Firms (E)	\$ 278,931.63
Warren				12	\$14,359,884.44	-2.53	Yes	Two Firms (A)	\$ 1,738,982.01
TOTAL (WITH ASPHALT PLA	4	\$ 1,748,661.30	-12.30	48	\$31,895,086.81	-1.40			
TOTAL (DISTRICT 3)	11	\$ 4,400,528.64	-14.64	62	\$37,545,475.29	-0.96			\$5,067,574.59

(A) These firms include Road Builders and Scotty's Contracting

(B) These firms include Glass Paving and Scotty's Contracting

(C) These firms include Gaddie-Shamrock, Glass Paving, Nally & Haydon Surfacing, and Scotty's Contracting

(D) These firms include Glass Paving, Nally & Haydon Surfacing, and Scotty's Contracting

(E) These firms include Road Builders, Rogers Group and Scotty's Contracting

Table 6.13: Summary Statistics for District 3 Firms

VARIABLES	Glass Paving		Scotty's Contracting and Stone	
	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.137	0.345	0.351	0.478
Distance Variables				
Distance (0 to 10 miles) [reference variable]	0.0479	0.214	0.109	0.312
Distance (11 to 20 miles)	0.0753	0.265	0.189	0.392
Distance (21 to 30 miles)	0.164	0.372	0.165	0.372
Distance (31 to 40 miles)	0.233	0.424	0.215	0.412
Distance (41 to 50 miles)	0.171	0.378	0.186	0.39
Distance (51 to 60 miles)	0.308	0.463	0.136	0.343
Other Control Variables				
Jobs Under Contract	1.808	0.881	9.460	4.007
Engineer's Estimate	726,377	1.14E+06	796,476	1.68E+06
Competitive Variables				
Number of Competitor Service Areas	6.397	2.504	6.484	2.782
Zero other competitive bid proposal purchased [reference variable]	0.0685	0.253	0.186	0.39
One other competitive bid proposal purchased	0.589	0.494	0.437	0.497
Two other competitive bid proposals purchased	0.233	0.424	0.174	0.38
Three or more other competitive bid proposals purchased	0.110	0.313	0.204	0.403
County Variables				
Project in same county-no rival	0.0616	0.241	0.189	0.392
Project in same county-rival	0.0548	0.228	0.0531	0.225
Project in adjacent county-no rival [reference variable]	0.329	0.471	0.221	0.416
Project in adjacent county-rival	0.555	0.499	0.537	0.499
Observations	146		339	

Table 6.14: Regression results for District 3 Firms

VARIABLES	Glass Paving		Scotty's Contracting	
	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.0834 (0.171)	0.0106 (0.0132)	0.0557 (0.0687)	0.0795 (0.0562)
Distance (21 to 30 miles)	-0.502*** (0.184)	0.0706 (0.0509)	-0.231*** (0.0864)	-0.0201 (0.0886)
Distance (31 to 40 miles)	-0.616*** (0.175)	0.0208 (0.0490)	-0.511*** (0.0859)	-0.254*** (0.0913)
Distance (41 to 50 miles)	-0.651*** (0.172)	-0.00754 (0.0321)	-0.577*** (0.0817)	-0.299*** (0.0878)
Distance (51 to 60 miles)	-0.649*** (0.173)	-0.00692 (0.0292)	-0.595*** (0.0804)	-0.343*** (0.0891)
Jobs Under Contract	0.0243** (0.0112)	0.00811 (0.00664)	0.00296 (0.00412)	0.00241 (0.00367)
Engineer's Estimate	6.51e-09 (5.12e-09)	2.46e-09 (2.40e-09)	-8.54e-09 (1.12e-08)	-8.54e-09 (7.60e-09)
Potential Competitors	-0.00299 (0.00382)	-0.00348 (0.00238)	-0.0134*** (0.00506)	-0.00315 (0.00393)
One competitive bid proposal purchased	-0.445*** (0.156)	-0.0170 (0.0176)	-0.419*** (0.0607)	-0.238*** (0.0469)
Two competitive bid proposals purchased	-0.501*** (0.157)	-0.0552 (0.0353)	-0.373*** (0.0744)	-0.251*** (0.0580)
Three or more competitive bid proposals purchased	-0.459*** (0.155)	-0.0215 (0.0218)	-0.366*** (0.0670)	-0.160*** (0.0500)
Project in same county-rival		0.0179 (0.0188)		-0.181* (0.108)
Project in adjacent county-no rival		-0.933*** (0.0471)		-0.189*** (0.0625)
Project in adjacent county-rival		-0.955*** (0.0504)		-0.544*** (0.0708)
Constant	1.080*** (0.119)	0.990*** (0.0204)	1.065*** (0.0582)	1.024*** (0.0426)
Observations	146	146	339	339
R-squared	0.674	0.842	0.652	0.740

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.15: Additional regression results for District 3 firms and firms outside District 3

VARIABLES	Glass Paving			Scotty's Contracting and Stone		
	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.0179 (0.0188)	0.0160 (0.0286)	0.0242 (0.0262)	-0.181* (0.108)	-0.166 (0.112)	-0.218* (0.114)
Project in adjacent county-no rival	-0.933*** (0.0471)	-0.931*** (0.0526)		-0.189*** (0.0625)	-0.0616 (0.0731)	
Project in adjacent county-rival	-0.955*** (0.0504)		-0.986*** (0.0879)	-0.544*** (0.0708)		-0.648*** (0.106)
Project in adjacent county-Commercial Pavers/Flynn Brothers		-0.0169 (0.0413)			-0.407*** (0.0959)	
Project in adjacent county-Gaddie-Shamrock		-0.933*** (0.0619)			-0.277*** (0.0814)	
Project in adjacent county-Glass Paving					-0.635*** (0.126)	
Project in adjacent county-Mago Construction		-0.921*** (0.0545)			-0.248** (0.0986)	
Project in adjacent county-Nally & Haydon		-0.960*** (0.0374)			-0.273*** (0.0964)	
Project in adjacent county-Qualified Paving		0.0188 (0.0331)				
Project in adjacent county-Road Builders					-0.347*** (0.0913)	
Project in adjacent county-Rogers Group					-0.427*** (0.0955)	
Project in adjacent county-Scotty's Contracting		-0.962*** (0.0896)				
Project in adjacent county-Yager Materials					-0.538*** (0.0960)	
Project in Butler County			-0.986*** (0.0867)			0.188** (0.0924)
Project in Edmonson County			-0.837*** (0.167)			0.0995* (0.0507)
Project in Metcalfe County			-0.916*** (0.0876)			0.116 (0.0799)
Constant	0.990*** (0.0204)	0.999*** (0.0611)	0.972*** (0.0332)	1.024*** (0.0426)	1.065*** (0.0506)	0.960*** (0.0340)
Observations	146	146	146	339	339	339
R-squared	0.842	0.842	0.848	0.740	0.749	0.849

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.15 (continued)

VARIABLES	Gaddie-Shamrock			Nally & Haydon Surfacing			Qualified Paving		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival									
Project in adjacent county-no rival	-0.158 (0.112)	-0.0981 (0.0845)		-0.288** (0.111)	-0.0603 (0.0698)		-0.330 (0.226)	-0.0127 (0.123)	
Project in adjacent county-rival	-0.200* (0.116)		-0.669*** (0.232)	-0.371*** (0.110)		-1*** (0)	-0.401* (0.234)		-0.207 (0.225)
Project in adjacent county-Commercial Pavers/Flynn Brothers					-0.0495 (0.0615)			-0.150 (0.139)	
Project in adjacent county-Gaddie-Shamrock					-0.209*** (0.0803)				
Project in adjacent county-Glass Paving		-0.0714 (0.0505)			-0.0967** (0.0448)			-0.0871 (0.0773)	
Project in adjacent county-Mago Construction		-0.157* (0.0863)			-0.163*** (0.0551)			0.127 (0.144)	
Project in adjacent county-Nally & Haydon		-0.152* (0.0892)						0.00343 (0.125)	
Project in adjacent county-Qualified Paving					0.0110 (0.0206)				
Project in adjacent county-Road Builders								-0.0748 (0.111)	
Project in adjacent county-Rogers Group									
Project in adjacent county-Scotty's Contracting		-0.0608 (0.0430)			-0.0584 (0.0639)			-0.115 (0.0959)	
Project in adjacent county-Yager Materials								-0.0240 (0.115)	
Project in Butler County									0.0841 (0.324)
Project in Edmonson County						-1*** (0)			-0.0398 (0.244)
Project in Metcalfe County			-0.744*** (0.187)			-1*** (0)			-0.272 (0.240)
Constant	1.096*** (0.0679)	1.064*** (0.0633)	0.979*** (0.0263)	1.048*** (0.0468)	1.037*** (0.0846)	1*** (0)	0.712*** (0.203)	0.773*** (0.228)	0.711*** (0.206)
Observations	142	142	142	291	291	291	131	131	131
R-squared	0.866	0.864	0.973	0.862	0.853	1.000	0.345	0.376	0.386

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.15 (continued)

VARIABLES	Road Builders & Parkway			Rogers Group		
	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival						
Project in adjacent county-no rival	0.328** (0.152)	0.329** (0.152)		-0.204* (0.107)	-0.192** (0.0953)	
Project in adjacent county-rival	0.141 (0.165)		-0.274 (0.171)	-0.474*** (0.123)		-0.421*** (0.124)
Project in adjacent county-Commercial Pavers/Flynn Brothers						
Project in adjacent county-Gaddie-Shamrock						
Project in adjacent county-Glass Paving						
Project in adjacent county-Mago Construction						
Project in adjacent county-Nally & Haydon						
Project in adjacent county-Qualified Paving		0.0913 (0.0559)				
Project in adjacent county-Road Builders				-0.461*** (0.146)		
Project in adjacent county-Rogers Group		0.123 (0.169)				
Project in adjacent county-Scotty's Contracting		0.111 (0.168)		-0.616*** (0.130)		
Project in adjacent county-Yager Materials		0.213 (0.161)		-0.322*** (0.109)		
Project in Butler County			-0.284 (0.176)			
Project in Edmonson County						
Project in Metcalfe County						
Constant	1.016*** (0.0766)	1.076*** (0.0927)	1.093*** (0.0744)	1.398*** (0.0827)	1.510*** (0.0982)	1.181*** (0.0580)
Observations	157	157	157	194	194	194
R-squared	0.825	0.827	0.901	0.797	0.812	0.926

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.11: District 3

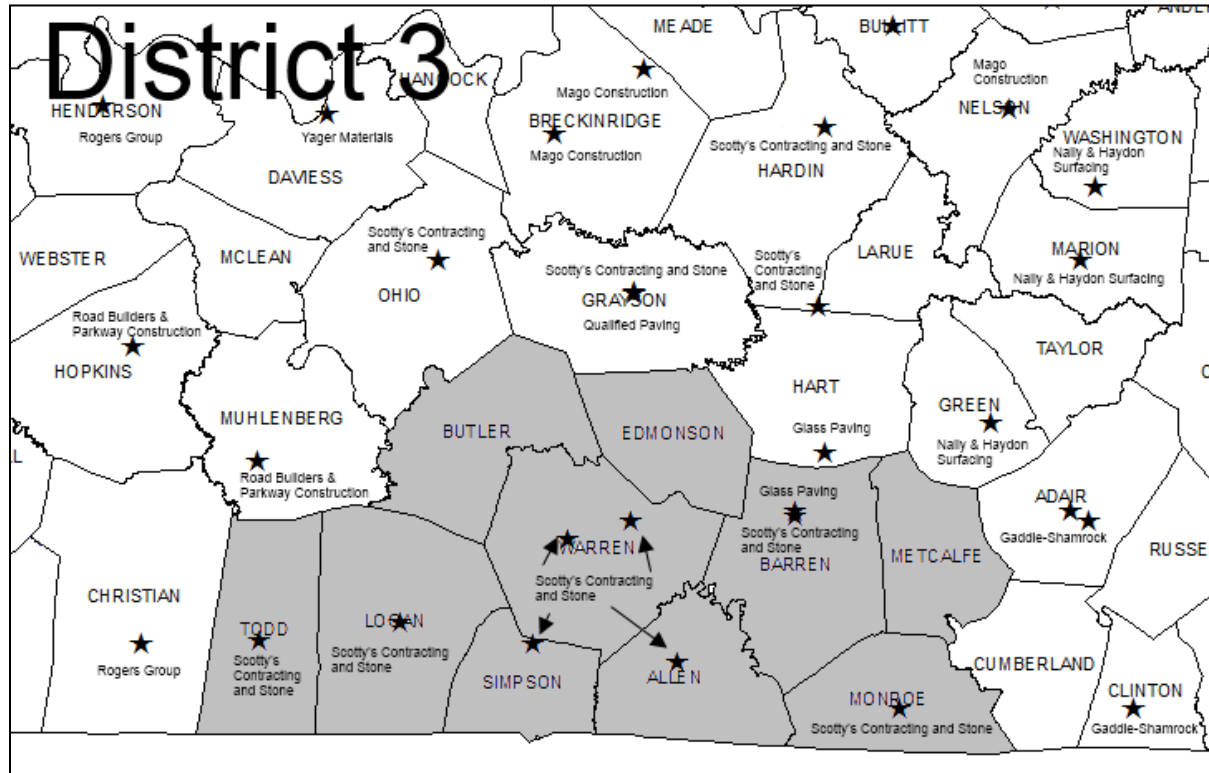


Figure 6.12: Glass Paving Service Area

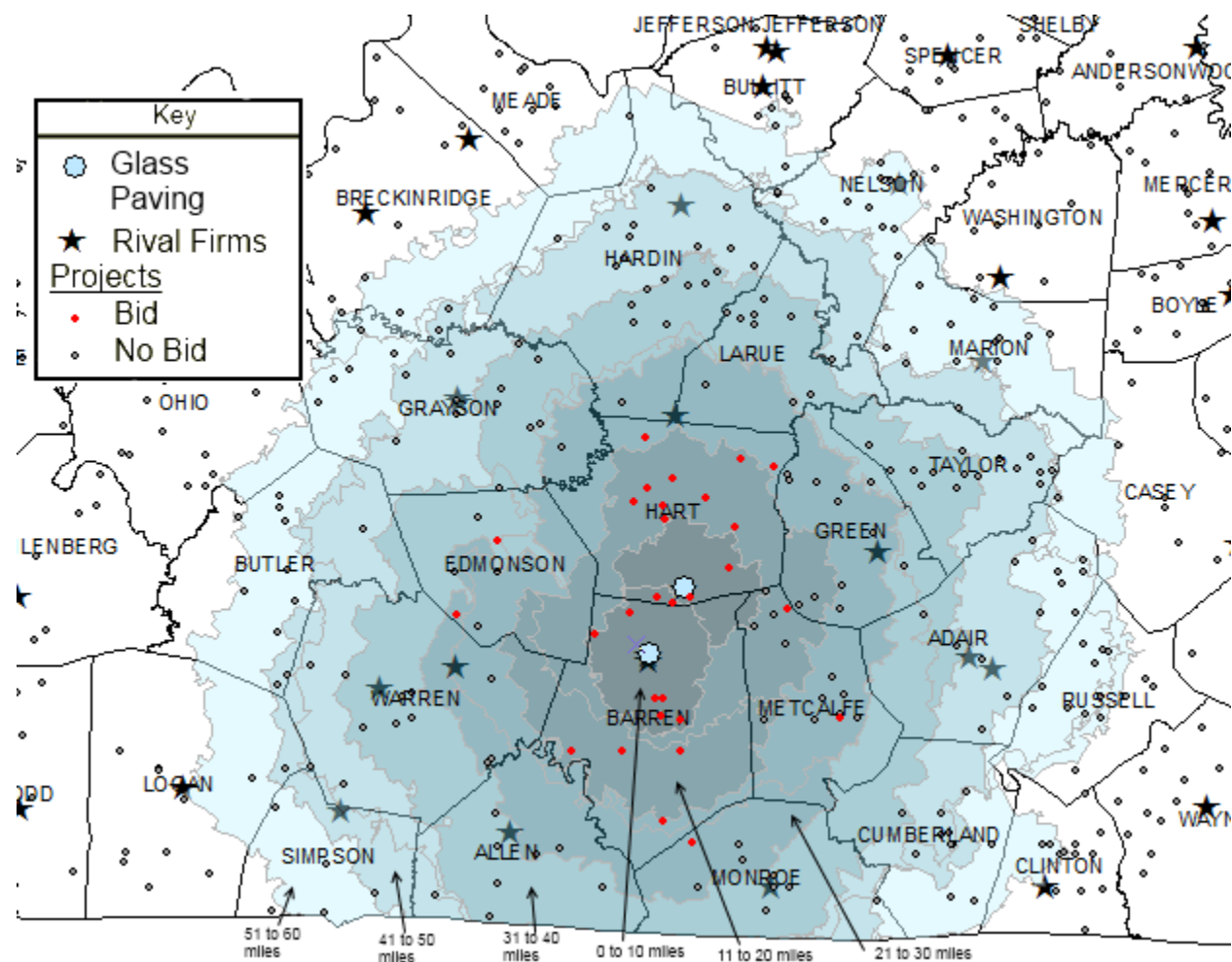
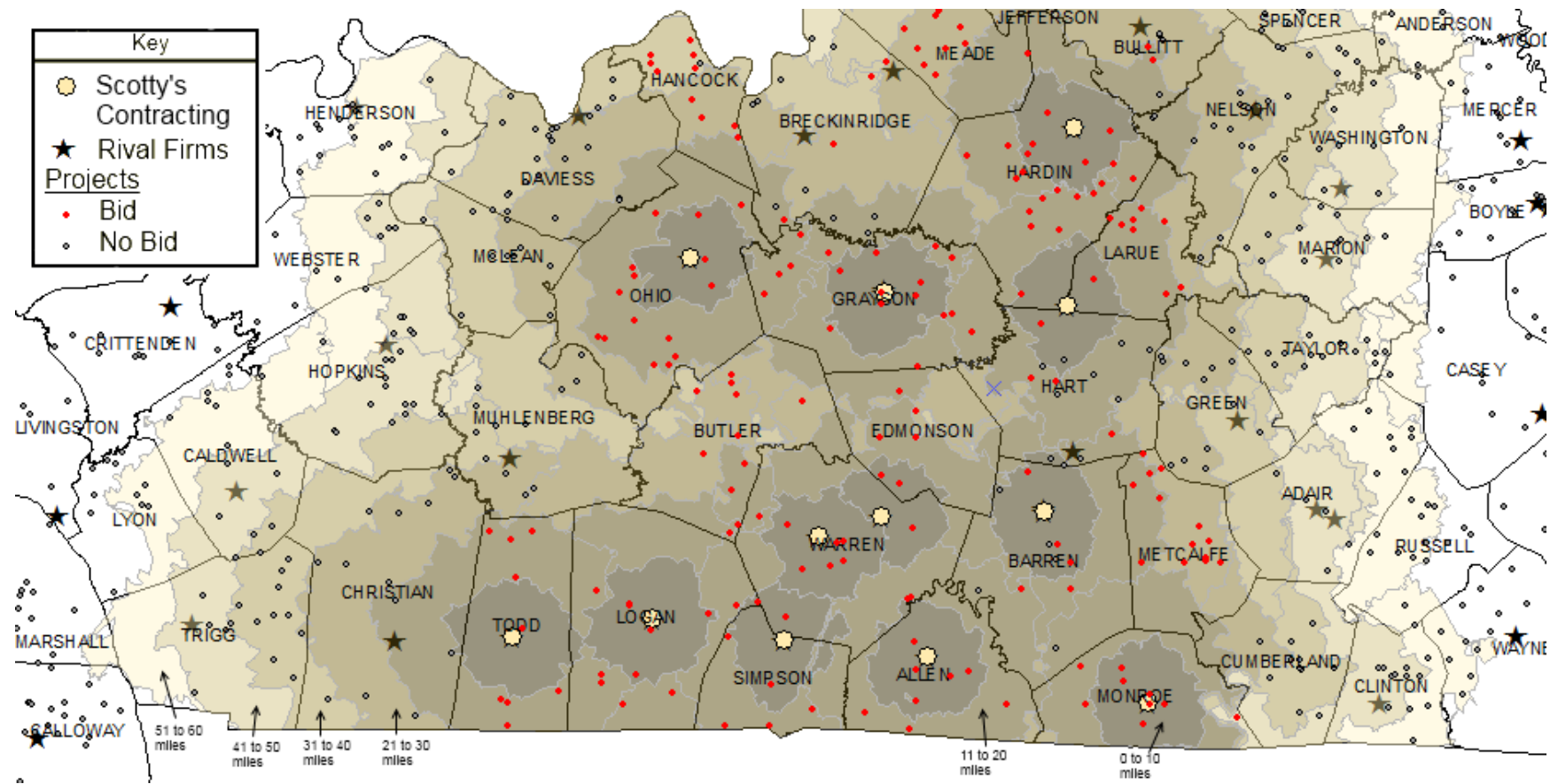


Figure 6.13: Scotty's Contracting and Stone Service Area



6.5 District 4 – Western Kentucky

District 4 consists of firms in south of the Louisville area in west-central Kentucky (see Figure 6.14). There are six firms that have plants located in this district and that compete on projects: Glass Paving, Mago Construction, Nally & Haydon Surfacing, Qualified Paving, and Scotty's Contracting and Stone. There are also multiple firms outside of the District 4 that are within reasonable distances to bid on projects. There is evidence of tacit collusion. The two areas where it is the most obvious are in Green, Marion, Taylor and Washington Counties where Nally & Haydon Surfacing bid on projects and other firms do not bid; and in Hart County where Glass Paving is the primary bidder on projects. There is evidence that Glass Paving and Scotty's Contracting had a period of retaliation where Glass Paving retaliated against Scotty's Contracting when Scotty's Contracting bid on a project in Hart County. This is detailed in full in the "Counties" section. There is also evidence of tacit collusion in Larue and Nelson Counties. The tacit collusion detected in the 10 counties in District 4 is marked by firms' refusal to bid against each other, which raises bid levels by \$4,980,890.92 above the competitive level. There is no conclusive evidence of tacit collusion in Meade County.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.16, Table 6.17, Table 6.18, and Table 6.19. A map for the firms follows the tables. The additional regression results found in Table 6.19 include all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.5.1 Firms with Asphalt Plants in District 4

GLASS PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Glass Paving has one asphalt plant located in District 4 in Hart County. Their primary competitors are Nally & Haydon Surfacing, Qualified Paving, and Scotty's Contracting. They bid on nine projects in Hart County in District 4 and were awarded all nine contracts. The contracted value of all of the nine projects was \$3,864,115.80. The average number of bidders on these projects was 1.11 bids. Scotty's Contracting only bid on one project in Hart County on July 26, 2006. On August 11, 2006 Glass Paving retaliated and bid on projects in Edmonson, Metcalfe

and Monroe Counties. The contracted value of these eight single-bid contracts averaged 5.36 percent above the engineer's estimate. The one project with two bidders is 10.15 percent below the engineer's estimate. That is a difference of 15.51 percent with the addition of competitors when Scotty's Contracting bid on the one project.

FIRM BID FUNCTION

The bid function for Glass Paving is in Table 6.18. The details of the bid function were discussed in the Glass Paving section for District 3. I will only highlight the important points of the bid function here. The primary thing that is motivating Glass Paving to bid is whether or not the project is located in a county where they have an asphalt plant. Looking at specification "B", they are less likely to bid on projects counties outside Barren and Hart Counties. This is broken out by specific firms in Table 6.19 and they avoid bidding against Gaddie-Shamrock, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting. They also avoid bidding on projects in Larue County where Scotty's Contracting is the primary bidder along with Taylor County where Nally & Haydon Surfacing wins all asphalt contracts, and Meade County. More of their bidding behavior will be explored in the "Counties" section.

MAGO CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mago Construction has three of their 12 plants located in District 4. There are two plants in Breckinridge County and one in Nelson County. Their primary competitors in District 4 are Nally & Haydon Surfacing and Scotty's Contracting. Next to Nelson County, Commercial Pavers and Flynn Brothers have asphalt plants in Bullitt County. They bid on 102 projects in Kentucky and 25 of those are in counties in District 4. Of those 25 bids, they were awarded 21 of the contracts. The contracted value of all of the 25 projects was \$16,961,463.72. The average number of bidders on these projects was 1.96 bids. Twelve of the 25 bids only had one bidder, Mago Construction. The contracted value of these projects was \$11,265,105.70, and the projects are located in Breckinridge and Nelson Counties. The contracted value of these 12 single-bid contracts averaged 8.87 percent below the engineer's estimate. For the other 13 projects with more than one bidder, the contracted value of the projects averages 17.63 percent below the engineer's estimate. That is a difference of 8.76 percent with the addition of competitors. What is interesting about these numbers is that the single-bid contracts have percentages lower than is typical. This could indicate that Mago Construction is facing a

competitive environment with the threat of bidding from other firms. This puts downward pressure on the bids. The nature of this competition will be looked at more in-depth in the “Counties” section below.

FIRM BID FUNCTION

The bid function for Mago Construction is in Table 6.18. Without the county variables (A), it indicates that once a project gets beyond 10 miles, the probability of Mago Construction bidding on a project diminishes significantly. This result is still the same when the county variables are added, but the magnitudes are not as great. The threat of competition decreases the probability of Mago Construction bidding on a project. As the number of potential competitors increases, they are less likely to bid on projects. There is also less likelihood of a firm bidding as competitors purchase bid proposals. The county variables indicate that Mago Construction is less likely to bid on projects in counties adjacent to counties where they have their asphalt plants. The magnitude is stronger when a rival firm has a plant in an adjacent county. Distance, competitor behavior, and which county a project is located in all significantly influence whether or not Mago Construction bids on a project. When specific rival firms are broken out, they are less likely to bid on projects in almost every other firm’s counties. The lone exception is that they avoid bidding against Qualified Paving in Grayson County. Scotty’s Contracting also has an asphalt plant in Grayson County.¹²³ In the counties without asphalt plants in District 4, they are less likely to bid on projects in Larue and Taylor Counties than on projects in counties where they have an asphalt plant. They are more likely to bid on projects in Meade County where they are an active bidder. More of their bidding behavior will be explored in the “Counties” section.

NALLY & HAYDON SURFACING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Nally & Haydon Surfacing has three asphalt plant located in District 4 in Green, Marion, and Washington Counties. Their primary competitors located in District 4 are Mago

¹²³ The fact that the variable for Qualified Paving is not significant may result from the fact that Grayson County is counted twice in the Mago Construction regression. It is included in the Qualified Paving variable and also in the Scotty’s Contracting variable in specification C. What is clear from the regression results is that Mago Construction generally avoids counties where Scotty’s Contracting has an asphalt plant.

Construction, Glass Paving, and Scotty's Contracting and Stone. Outside District 4, The Allen Company (District 7), Lincoln County Ready Mix (District 7), Gaddie-Shamrock (District 8) and Hinkle Contracting (District 8) have plants in counties adjacent to Green, Marion, and Washington Counties. Nally & Haydon Surfacing bid on 30 projects in District 4 and were awarded all 30 projects. They did not bid on any other projects in any other districts. The contracted value of all of the 30 projects was \$12,967,285.12. The average number of bidders on these projects was 1.03 bids. All but one of the 30 projects only had one bidder. The contracted value of these 29 single-bid contracts averaged 1.72 percent above the engineer's estimate. For the one project with two bidders, the contracted value of the projects was 15.29 percent below the engineer's estimate.

FIRM BID FUNCTION

The bid function for Nally & Haydon Surfacing is in Table 6.18. Once a project gets beyond 20 miles, the probability of Nally & Gibson bidding on a project diminishes significantly in both specifications "A" and "B". "Jobs Under Contract" is positive and significant. This means the more jobs they have when they bid on a project the more likely they are to bid on the project. Looking at Table 6.17, they average only 1.6 jobs under contract when they bid on a project. It is possible this is indicating they have excess capacity and can take on more projects. The bid proposal variables are negative and significant in both specifications. If competitors are purchasing bid proposals they are less likely to bid on the project. The county variables also significantly impact whether or not they bid on a project. They are less likely to bid on a project outside the three counties where they have an asphalt plant. Taylor County (no asphalt plant) is one exception to this behavior. They bid on every project in Taylor County. But beyond Taylor County they do not bid on any other projects in adjacent counties. When the firms are specifically broken out in Table 6.19, they are less likely to bid on projects against Glass Paving and Mago Construction in District 4. More of their bidding behavior will be explored in the "Counties" section.

QUALIFIED PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Qualified Paving has one asphalt plant located in Grayson County where Scotty's Contracting also has an asphalt plant. Their primary competitors are Glass Paving, Mago Construction and Scotty's Contracting. They bid on 17 projects in District 2 (Hancock County),

District 3 (Butler and Edmonson County) and District 4 (Breckinridge, Grayson and Hardin Counties). They were awarded 10 of those 17 contracts. The contracted value of the 17 projects was \$12,120,920.94. The average number of bidders on these projects was 2.47 bids, and all of the projects had more than one bidder. The contracted value of these 17 contracts averaged 20.87 percent below the engineer's estimate. Within District 4, they bid on 11 projects that have a contracted value of \$10,342,675.28 which average 20.72 percent below the engineer's estimate. Qualified Paving is an active firm that bids on projects and puts downward pressure on bids.

FIRM BID FUNCTION

The bid function for Qualified Paving is in Table 6.18. Without the county variables, it indicates that once a project gets beyond 20 miles, the probability of Qualified Paving bidding on a project diminishes significantly. However, when the county variables are added none of the distance variables are significant and most of them remain negative. Looking at Figure 6.18, Qualified Paving bids on projects in all the distance rings except 51 to 60 miles. "Jobs Under Contract" is positive and significant. This means the more jobs they have when they bid on a project the more likely they are to bid on the project. Looking at Table 6.17, they average only 1.03 jobs under contract when they bid on a project. This could be indicating they have excess capacity and are willing to bid on more projects. When the county variables are added, they are less likely to bid on a project in an adjacent county with a rival firm than in Grayson County where they have their asphalt plant. However, when specific firms are included in the regression this effect goes away (see Table 6.19). More of their bidding behavior will be explored in the "Counties" section.

SCOTTY'S CONTRACTING AND STONE

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Scotty's Contracting and Stone has three of their 12 plants located in District 4. Their plants are located in Grayson and Hardin Counties. They have a number of competitors in District 4 including Glass Paving, Mago Construction, Nally & Haydon Surfacing, and Qualified Paving. Other firms outside located outside the district include Commercial Pavers and Flynn Brothers. They bid on 119 projects in Kentucky and were awarded 96 of those contracts. Of those 119 bids, 37 bids were in District 4. The average number of bids on these 37 projects was 2.24. The contracted value of these 37 projects is \$24,235,696.24. Scotty's Contracting was the

only bidder on eight of the 37 bids and these eight bids have a contracted value of \$4,368,383.20 which average 0.07 percent below the engineer's estimate. For the other 29 projects Scotty's Contracting bid on and have two or more bidders the contracted value averages 18.16 percent below the engineer's estimate. Whether there is evidence of tacit collusion will be explored on a county-by-county basis following the Scotty's Contracting section.

FIRM BID FUNCTION

The results of the bid function for Scotty's Contracting were discussed in detail in the District 2 section. The important points of the bid function will be highlighted here. Distance impacts whether or not they bid on a project. All three county variables are significant. Scotty's Contracting is more likely to bid on a project in a county where they have an asphalt plant than an adjacent county. The specific firms they avoid bidding against include Glass Paving, Mago Construction, and Nally & Haydon Surfacing in District 4. They actively bid on projects in Larue and Meade Counties while avoiding bidding in Taylor County. The analysis in this section will only focus on their bidding behavior and their rivals bidding behavior in District 4. Analysis of the District 2 and 3 are contained in their respective sections.

6.5.2 Counties in District 4

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.19). The additional regressions for firms outside District 4 will be discussed and regressions for those firms are in Table 6.19. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.18). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

LARUE COUNTY

There are a total of four projects in Larue County. The total contracted value of these projects is \$1,198,744.10 which averages 4.06 percent below the engineer's estimate. The

competitive average for District 4 projects is 17.91 percent below the engineer's estimate (see Table 6.16). Scotty's Contracting is the major firm that bid on these four projects. Certified Construction Company of Kentucky bid on one project in Larue County. Besides Scotty's Contracting, there are seven firms that are potential competitors and could bid on all projects in Larue County including Commercial Pavers, Flynn Brothers, Gaddie-Shamrock, Glass Paving, Mago Construction, Nally & Haydon Surfacing, and Qualified Paving.

Looking at the "Larue County" variable in Table 6.19, there is no statistical difference between Scotty's Contracting bidding on projects in counties where they have asphalt plants and in Larue County. Larue County is one of the counties where they bid. For the other firms, Commercial Pavers, Gaddie-Shamrock, Glass Paving, Mago Construction, and Nally & Haydon Surfacing are all less likely to bid on projects in Larue County where Scotty's Contracting actively bids (see Table 6.19). The question is whether Scotty's Contracting returns the favor by not bidding on projects in counties where these firms bid. As has been documented in previous districts, Scotty's Contracting tacitly colludes with Glass Paving and Mago Construction. Nally & Haydon Surfacing avoids bidding in Larue County and Scotty's Contracting is less likely to bid on projects where Nally & Haydon has an asphalt plant and in Taylor County where they actively bid and win contracts. Scotty's Contracting is also less likely to bid on projects in Bullitt and Jefferson Counties where Commercial Pavers has their asphalt plant. Scotty's Contracting also avoids bidding in Adair County where Gaddie-Shamrock has an asphalt plant. There is clear evidence that firms tacitly collude with Scotty's Contracting and do not bid in Larue County. The financial impact of this refusal to bid is not very high since Certified Construction is a competitive threat in Larue County. However, if these other firms actively bid on projects in Larue County it would drive bids down even further. The single-bid contracts are \$118,135.80 above the competitive level for District 4.

MEADE COUNTY

There are a total of seven projects in Meade County. The total contracted value of these projects is \$2,924,153.46 which averages 18.37 percent below the engineer's estimate. Every project in Meade County has more than one bidder. Mago Construction and Scotty's Contracting are the two firms that are awarded projects in Meade County. Other firms that bid on projects are Certified Construction (1 bid), Commercial Pavers (2 bids) and Indiana firm Gohmann Asphalt and Construction (7 bids). Other potential competitors include Flynn Brothers and

Qualified Paving. Clearly the level of firms bidding on projects drives the bid levels down substantially. It is interesting to note that Mago Construction and Scotty's Contracting bid so actively against each other in Meade County, but do not bid against each other in other counties such as Hardin County. There are certain counties like Meade County where the absence of a plant in the county creates an open county where numerous firms bid on projects even if they are tacitly colluding elsewhere. There is no indication that any tacit collusion is occurring in Meade County. Flynn Brothers and Qualified Paving do not bid in Meade County and it is not because they are tacitly colluding with the other firms.

TAYLOR COUNTY

There are a total of nine projects in Taylor County. The total contracted value of these projects is \$4,187,745.00 (see Table 6.16), which averages 3.82 percent below the engineer's estimate. Out of these nine projects, eight of them have only one bidder. The one multiple-bid project averaged 15.29 percent below the engineer's estimate. Nally & Haydon Surfacing wins every contract, and Burton Paving is the one firm that bids against Nally & Haydon Surfacing. The major firms that could potentially bid on projects in Taylor County include Glass Paving, Mago Construction, Scotty's Contracting, The Allen Company (District 7), Lincoln Ready Mix (District 7), Gaddie-Shamrock (District 8), and Hinkle Contracting (District 8). All of these firms are less likely to bid on projects in Taylor County than on projects in counties where they have their asphalt plants, holding all else constant. These are a lot of potential competitors for Nally & Haydon Surfacing, yet none of them bid on projects. In turn there is evidence that Nally & Haydon Surfacing returns the favor and is less likely to bid on projects where Gaddie-Shamrock, Glass Paving, Hinkle Contracting, Lincoln Ready Mix, and Mago Construction have asphalt plants (see Table 6.19). We have also seen they avoid bidding against Scotty's Contracting in Larue County. There is substantial evidence that firms avoid bidding in Taylor County and Nally & Haydon Surfacing does not bid against these firms. This increases bids above the competitive level by about \$654,076.66.

COUNTIES WITH ASPHALT PLANTS

BRECKINRIDGE AND NELSON COUNTIES

In these two counties, Mago Construction has three asphalt plants. There are 18 projects in these counties. The contracted value of these projects is \$14,037,310.26, which

averages 11.50 percent below the engineer's estimate. The average for competitive projects in District 4 is 17.91 percent below the engineer's estimate. There are a total of 12 projects that have only one bidder and in every case that bidder is Mago Construction. Two of the projects are in Breckinridge County and the rest are in Nelson County. The contracted value of the 12 single-bid contracts averages 8.87 percent below the engineer's estimate and the contracted value of the other six multi-bid projects average 16.77 percent below the engineer's estimate.

In Breckinridge County, the potential competitors that could bid on projects include Mago Construction, Qualified Paving, Scotty's Contracting and Yager Materials. The firms Qualified Paving, Mago Construction, and Scotty's Contracting all bid on projects in Breckinridge County. This competition puts downward pressure on the bids. In the additional regressions, a variable for adjacent county projects in counties where Mago Construction has an asphalt plant was included in the Qualified Paving and Scotty's Contracting regressions. This variable is not significant for Qualified Paving, but it is significant and negative for Scotty's Contracting and Yager Materials. In turn the additional regression for Mago Construction is negative and significant for Scotty's Contracting and Yager Materials (see Table 6.19). There is evidence of tacit collusion between Mago Construction and these other two firms.

In general, Scotty's Contracting is less likely to bid on projects in counties where Mago Construction has an asphalt plant. It is unclear why Scotty's Contracting bids against Mago Construction. While there is evidence of coordination of bids, it appears that Scotty's Contracting may cheat and bid on projects in Breckinridge County. Mago Construction, on the other hand, never bids against Scotty's Contracting in counties where Scotty's Contracting has their asphalt plants. Scotty's Contracting bid on projects in Breckinridge County, but not on every project that was up for bid.¹²⁴ In 2007, Scotty's Contracting did not bid on any projects in the county, and Mago Construction was the lone bidder on two projects. Unlike Barren and Hart Counties where Glass Paving retaliated against Scotty's Contracting, there is no evidence that Mago Construction retaliates against Scotty's Contracting. With this in mind, there is evidence of tacit collusion between Mago Construction and Yager Materials and between Mago

¹²⁴ In looking at the three projects that Scotty's Contracting bid on there is no characteristic or other thing that would explain why they only bid on these projects. All the projects in Breckinridge County are all resurfacing projects. Mago Construction always bid on the projects that Scotty's Contracting bid.

Construction and Scotty's Contracting even though they do bid in Breckinridge County. This is specifically evident in 2007 in Breckinridge County. This increases bids above the competitive level by about \$185,534.50.

Gohmann Asphalt bid on one project in Nelson County. Other than that no other firms bid against Mago Construction on the projects. Firms that have all of the projects in Nelson County in their 60 mile service area and could potentially bid on all projects include The Allen Company (District 7), Commercial Pavers (District 5), Flynn Brothers (District 5), Lincoln County Ready Mix (District 7), Nally & Haydon Surfacing (District 4), Scotty's Contracting (District 4), and Shelbyville Asphalt (District 5). Adding the Mago Construction variable to these firms' bid functions produces the result that The Allen Company, Commercial Pavers, Lincoln County Ready Mix, Nally & Haydon Surfacing, Scotty's Contracting, and Shelbyville Asphalt are less likely to bid on projects in counties where Mago Construction has their asphalt plants. In turn, Mago Construction is less likely to bid on projects in those firms' county. There is evidence of tacit collusion. The result of the tacit collusion is single-bid contracts average \$739,074.22 above the competitive level for District 4.

GRAYSON AND HARDIN COUNTIES

In these two counties, Scotty's Contracting has three asphalt plants. Qualified Paving has a plant in Grayson County. There are 22 projects in these two counties. The contracted value of these projects is \$18,155,362.62, which averages 14.59 percent below the engineer's estimate. The competitive average for District 4 is 17.91 percent below the engineer's estimate. Only five projects have one bidder, and in every case that bidder is Scotty's Contracting. The contracted value of the five single-bid contracts averages 2.55 percent above the engineer's estimate and the contracted value of the other 18 multi-bid projects average 19.63 percent below the engineer's estimate.

In Grayson County, of the 11 projects only four of them have one bidder. What is interesting is that Qualified Paving stopped bidding on projects in Grayson County after April 28, 2006. Once Qualified Paving stopped bidding bid levels crept up from as low as 30 percent below the engineer's estimate to 10 percent above the engineer's estimate on the a bid in

2007.¹²⁵ The main firms that bid on projects in Grayson County are Qualified Paving (6 bids) and Scotty's Contracting (11 bids). The potential bidders for Grayson County include Glass Paving, Mago Construction, Qualified Paving, and Scotty's Contracting. As has been documented earlier there is evidence of tacit collusion between Glass Paving and Scotty's Contracting and also between Mago Construction and Scotty's Contracting. Looking at the Mago Construction map in Figure 6.16, Mago Construction does not bid on any projects in Grayson County even a project that is just across the border from Breckinridge County. The additional regressions confirm that these firms are less likely to bid on projects in each other's counties (see Table 6.19). There is no evidence of tacit collusion between Qualified Paving and the other firms. If Mago Construction and Glass Paving bid in Grayson County, it could drive the bid levels down even further. The four single-bidder contracts average 4.73 percent above the engineer's estimate and 22.64 percent above the District 4 multi-bid average. This results in bids that are \$576,987.51 higher than the competitive bid level.

Hardin County is more competitive than Grayson County and only has one single-bid contract out of 12 projects. The projects in Hardin County average 16.95 percent below the engineer's estimate. There are a total of five firms that bid on projects in Hardin County including Certified Construction, Commercial Pavers, Gohmann Asphalt, Qualified Paving, and Scotty's Contracting. Other potential competitors include Glass Paving, Mago Construction and Nally & Haydon Surfacing. Mago Construction could reasonably bid on projects in Hardin County but does not. Looking at Figure 6.16, Mago Construction bids on projects in Hancock County that is in the same distance ring as some of the projects in Hardin County. The evidence cited earlier shows that tacit collusion is occurring between Mago Construction and Scotty's Contracting and it extends into Hardin County. Commercial Pavers is also less likely to bid on projects in counties where Scotty's Contracting has an asphalt plant (see Table 6.19). However, they bid on four projects in Hardin County. It has been documented previously that Glass Paving avoids bidding where Scotty's Contracting has asphalt plants and bids. There is no evidence that Nally &

¹²⁵ The last bid Qualified Paving bid on April 28, 2006 the bid was 11.45 percent below the engineer's estimate. On July 21, 2006, the one bid was 1.25 percent below the engineer's estimate. Three bids were let on May 25, 2007. Those three bids averaged 6.72 percent above the engineer's estimate. It is not clear why Qualified Paving stopped bidding. They officially dissolved in 2009. Source: "Kentucky.Gov Fasttrack Business Organization Search," <https://app.sos.ky.gov/ftsearch/default.aspx>.

Haydon Surfacing not bidding in Hardin County is a result of tacit collusion with Scotty's Contracting (see Table 6.19).

The most conclusive evidence is that Mago Construction and Scotty's Contracting and Glass Paving and Scotty's Contracting are tacitly colluding. There is evidence of tacit collusion between Scotty's Contracting and Commercial Pavers even though they bid in Hardin County. What is difficult about this analysis is that even in a county where multiple firms bid on projects there is still evidence of tacit collusion. Its impact is lessened by the fact that the county is so competitive, however there is still evidence it is occurring. If Glass Paving and Mago Construction actively bid it would drive bid levels down. Since there is only one single-bid contract, the fact that Mago Construction and Glass Paving do not bid results in bids that are \$110,799.34 higher than the competitive bid level. The bidding is very competitive and the bid levels are very low. If Glass Paving and Mago Construction bid and Commercial Pavers bid more regularly it would drive bids down even further. The evidence supports that tacit collusion is occurring between these firms and Scotty's Contracting.

GREEN, MARION AND WASHINGTON COUNTIES

In these three counties, Nally & Haydon Surfacing is the only firm that has asphalt plants. They are also the only firm that bids on projects in these counties. There are 21 projects in these counties. The contracted value of these projects is \$8,779,540.12, which averages 3.05 percent above the engineer's estimate. The competitive average District 4 is 17.91 percent below the engineer's estimate.

Firms that could bid on projects in Green County include District 4 firms Glass Paving, Nally & Haydon Surfacing, and Scotty's Contracting along with Gaddie-Shamrock from District 8. Nally & Haydon Surfacing is the only firm that bids on projects in this county. According to the additional regressions, all the other firms are less likely to bid on projects where Nally & Haydon Surfacing has an asphalt plant. The additional regression for Nally & Haydon Surfacing in Table 6.19 shows that they are less likely to bid on projects in counties where all but Scotty's Contracting has an asphalt plant when the other factors are controlled. However, there is evidence of tacit collusion between Scotty's Contracting and Nally & Haydon Surfacing in Larue County. In return Scotty's Contracting does not bid in any of the counties where Nally & Haydon Surfacing has an asphalt plant. There is evidence of tacit collusion between Nally & Haydon

Surfacing and Glass Paving, Gaddie-Shamrock, and Scotty's Contracting (see Table 6.19). Since these firms do not bid on projects it increases bid levels. This tacit collusion increases bids above the competitive level by about \$523,933.70.

Firms that could bid on projects in Marion County include The Allen Company (District 7), Commercial Pavers (District 5), Flynn Brothers (District 5), Gaddie-Shamrock (District 8), Glass Paving (District 4), Hinkle Contracting (District 8), Lincoln County Ready Mix (District 7), Mago Construction (District 4), Nally & Haydon Surfacing (District 4), and Scotty's Contracting (District 4). Nally & Haydon Surfacing is the only firm that bids on projects in this county. According to the additional regressions, all of these firms are less likely to bid in the counties where Nally & Haydon Surfacing has an asphalt plant when all the other factors are controlled (see Table 6.19). The additional regression for Nally & Haydon Surfacing in Table 6.19 shows that they are less likely to bid on projects in counties where Gaddie-Shamrock, Glass Paving, Hinkle Contracting, Lincoln County Ready Mix, and Mago Construction have asphalt plants. Nally & Haydon Surfacing and Scotty's Contracting are tacitly colluding in Larue County as documented earlier. It is amazing that all these firms could reasonably bid on projects in Marion County but they choose not, and in turn Nally & Haydon Surfacing does not bid on projects in counties where they bid. Since these six firms refrain from bidding, Nally & Haydon Surfacing is the only bidder. This tacit collusion increases bids above the competitive level by about \$610,026.92.

In Washington County there are many firms that could potentially bid on projects including The Allen Company (District 7), Commercial Pavers (District 5), Flynn Brothers (District 5), H.G. Mays (District 5), Lincoln County Ready Mix (District 7), Mago Construction (District 4), Nally & Haydon Surfacing (District 4), Scotty's Contracting (District 4), and Shelbyville Asphalt (District 5). Nally & Haydon Surfacing is the only firm that bids on projects in this county. The firms that are less likely to bid on projects in counties where Nally & Haydon Surfacing include H.G. Mays, Lincoln County Ready Mix, and Mago Construction; and Nally & Haydon Surfacing is less likely to bid in counties where these firms bid include (see Table 6.19). Nally & Haydon Surfacing and Scotty's Contracting are tacitly colluding in Larue County as documented earlier. Since these firms refuse to bid, Nally & Haydon Surfacing is the only bidder. This tacit collusion increases bids above the competitive level by about \$696,688.33.

HART COUNTY

In the District 3 section, a period of retaliatory bidding was highlighted between Glass Paving and Scotty's Contracting. Glass Paving bid on and won all of the 9 projects in Hart County. They were the only bidder on all the projects except one on July 21, 2006. Scotty's Contracting bid on this project. It was followed up by retaliatory bids by Glass Paving in Edmonson, Metcalfe and Monroe Counties on August 11, 2006. Scotty's Contracting did not bid on any more projects in counties where Glass Paving typically bids including Hart County through 2007. This example highlights how Scotty's Contracting and Glass Paving enforces their tacit collusion. The single-bid projects in Hart County average 5.36 percent above the engineer's estimate or 23.27 percent above the multi-bid average for District 4. The one bid where Scotty's Contracting bid was 10.15 percent below the engineer's estimate. It is clear that if Scotty's Contracting bid more aggressively on bids in Hart County it would drive bid levels down. Other potential firms that could bid on projects in Hart County include Mago Construction, Nally & Haydon Surfacing, and Qualified Paving. According to Table 6.19, Mago Construction and Nally & Haydon Surfacing are less likely to bid on projects in counties where Glass Paving has an asphalt plant including Hart County. In turn Glass Paving does not bid on projects in their counties. This tacit collusion leads to bids that are \$756,633.94 above the multi-bid average for District 4.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 4 is very interesting. There is evidence that Glass Paving and Scotty's Contracting are engaging in tacitly collusive behavior. It is being maintained through retaliation when Scotty's Contracting cheated and bid in Hart County where they were not supposed to bid. Glass Paving retaliated by bidding in Edmonson, Metcalfe and Monroe Counties where they typically do not bid. After that retaliation both firms bid in their respective counties for the rest of 2007. Firms refuse to bid in counties where Nally & Haydon Surfacing have their asphalt plants and in Taylor County. These are only a few examples. This tacit collusion results in bids that are \$4,980,890.92 above the competitive level. Not all of the behavior is collusive. In Meade Counties there are numerous firms that bid on projects and it is very competitive.

Table 6.16: Summary of Tacit Collusion for District 4 Firms

COUNTY	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Larue	1	\$ 321,063.60	-2.88	3	\$ 877,680.50	-4.45	Yes	Six Firms (A)	\$ 118,135.80
Meade	7	\$ 2,924,153.46	-18.37				No	-	Competitive
Taylor	1	\$ 132,713.00	-15.29	8	\$ 4,055,032.00	-1.78	Yes	Seven Firms (B)	\$ 654,076.66
TOTAL (WITHOUT ASPHALT PLANTS)	9	\$ 3,377,930.06	-16.31	11	\$ 4,932,712.50	-2.51			
WITH ASPHALT PLANTS									
Breckinridge	5	\$ 2,444,341.46	-16.89	2	\$ 1,000,186.00	0.64	Yes	Three Firms (C)	\$ 185,534.50
Grayson	6	\$ 4,984,438.88	-22.73	4	\$ 2,548,531.40	4.73	Yes	Three Firms (D)	\$ 576,987.51
Green				6	\$ 2,449,143.83	3.85	Yes	Four Firms (E)	\$ 532,933.70
Hardin	11	\$ 9,680,221.04	-17.93	1	\$ 942,171.30	-6.15	Yes	Four Firms (F)	\$ 110,799.34
Hart	1	\$ 612,573.30	-10.15	8	\$ 3,251,542.50	5.36	Yes	Four Firms (G)	\$ 756,633.94
Marion				7	\$ 2,928,597.80	2.92	Yes	Seven Firms (H)	\$ 610,026.92
Nelson	1	\$ 327,863.10	-16.17	10	\$10,264,919.70	-10.77	Yes	Seven Firms (I)	\$ 739,074.22
Washington				8	\$ 3,401,798.49	2.57	Yes	Five Firms (J)	\$ 696,688.33
TOTAL (WITH ASPHALT PLANTS)	24	\$ 18,049,437.78	-18.52	46	\$26,786,891.02	0.29			
TOTAL (DISTRICT 4)	33	\$ 21,427,367.84	-17.91	57	\$31,719,603.52	-0.25			\$4,980,890.92

(A) These firms include Commercial Pavers, Gaddie-Shamrock, Glass Paving, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting

(B) These firms include Gaddie-Shamrock, Glass Paving, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting

(C) These firms include Mago Construction, Scotty's Contracting, and Yager Materials

(D) These firms include Glass Paving, Mago Construction and Scotty's Contracting

(E) These firms include Gaddie-Shamrock, Glass Paving, Nally & Haydon Surfacing, and Scotty's Contracting.

(F) These firms include Commercial Pavers, Glass Paving, Mago Construction, and Scotty's Contracting

(G) These firms include Glass Paving, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting

(H) These firms include Gaddie-Shamrock, Glass Paving, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting.

(I) These firms include The Allen Company, Commercial Pavers, Mago Construction, Lincoln County Ready Mix, Nally & Haydon Surfacing, Scotty's Contracting, and Shelbyville Asphalt

(J) These firms include H.G Mays, Lincoln County Ready Mix, Mago Construction, Nally & Haydon Surfacing, and Scotty's Contracting

Table 6.17: Summary Statistics for District 4 Firms

VARIABLES	Mago Construction		Glass Paving		Nally & Haydon Surfacing		Qualified Paving		Scotty's Contracting and Stone	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.179	0.384	0.137	0.345	0.103	0.305	0.130	0.337	0.351	0.478
Distance Variables										
Distance (0 to 10 miles) [reference variable]	0.0684	0.253	0.0479	0.214	0.0344	0.182	0.0382	0.192	0.109	0.312
Distance (11 to 20 miles)	0.219	0.414	0.0753	0.265	0.0962	0.295	0.0458	0.21	0.189	0.392
Distance (21 to 30 miles)	0.281	0.45	0.164	0.372	0.144	0.352	0.0840	0.278	0.165	0.372
Distance (31 to 40 miles)	0.167	0.373	0.233	0.424	0.155	0.362	0.153	0.361	0.215	0.412
Distance (41 to 50 miles)	0.132	0.338	0.171	0.378	0.251	0.434	0.351	0.479	0.186	0.39
Distance (51 to 60 miles)	0.133	0.34	0.308	0.463	0.320	0.467	0.328	0.471	0.136	0.343
Other Control Variables										
Jobs Under Contract	6.147	2.196	1.808	0.881	1.598	0.996	1.015	0.832	9.460	4.007
Engineer's Estimate	638,763	1.62E+06	726,377	1.14E+06	707,965	1.61E+06	1.002e+06	2.29E+06	796,476	1.68E+06
Competitive Variables										
Number of Competitor Service Areas	8.968	3.021	6.397	2.504	9.515	3.239	6.031	1.823	6.484	2.782
Zero other competitive bid proposal purchased [reference variable]	0.0544	0.227	0.0685	0.253	0.0790	0.27	0	-	0.186	0.39
One other competitive bid proposal purchased	0.446	0.497	0.589	0.494	0.436	0.497	0.542	0.5	0.437	0.497
Two other competitive bid proposals purchased	0.302	0.459	0.233	0.424	0.251	0.434	0.252	0.436	0.174	0.38
Three or more other competitive bid proposals purchased	0.198	0.399	0.110	0.313	0.234	0.424	0.206	0.406	0.204	0.403
County Variables										
Project in same county-no rival	0.128	0.334	0.0616	0.241	0.0722	0.259	0	-	0.189	0.392
Project in same county-rival	0.0105	0.102	0.0548	0.228	0	-	0.0763	0.267	0.0531	0.225
Project in adjacent county-no rival [reference variable]	0.277	0.448	0.329	0.471	0.251	0.434	0.267	0.444	0.221	0.416
Project in adjacent county-rival	0.584	0.493	0.555	0.499	0.677	0.468	0.656	0.477	0.537	0.499
Observations	570		146		291		131		339	

Table 6.18: Regression results for District 4 Firms

VARIABLES	Glass Paving		Mago Construction		Nally & Haydon Surfacing		Qualified Paving		Scotty's Contracting and Stone	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.0834 (0.171)	0.0106 (0.0132)	-0.454*** (0.0581)	-0.249*** (0.0635)	-0.101 (0.0891)	0.0391 (0.0679)	-0.372 (0.261)	-0.318 (0.285)	0.0557 (0.0687)	0.0795 (0.0562)
Distance (21 to 30 miles)	-0.502*** (0.184)	0.0706 (0.0509)	-0.727*** (0.0514)	-0.425*** (0.0716)	-0.409*** (0.143)	-0.219* (0.114)	-0.381* (0.215)	-0.00350 (0.310)	-0.231*** (0.0864)	-0.0201 (0.0886)
Distance (31 to 40 miles)	-0.616*** (0.175)	0.0208 (0.0490)	-0.829*** (0.0478)	-0.505*** (0.0724)	-0.457*** (0.144)	-0.265** (0.116)	-0.667*** (0.168)	-0.284 (0.282)	-0.511*** (0.0859)	-0.254*** (0.0913)
Distance (41 to 50 miles)	-0.651*** (0.172)	-0.00754 (0.0321)	-0.862*** (0.0479)	-0.515*** (0.0742)	-0.437*** (0.142)	-0.257** (0.114)	-0.622*** (0.169)	-0.244 (0.281)	-0.577*** (0.0817)	-0.299*** (0.0878)
Distance (51 to 60 miles)	-0.649*** (0.173)	-0.00692 (0.0292)	-0.889*** (0.0491)	-0.545*** (0.0763)	-0.449*** (0.143)	-0.254** (0.114)	-0.739*** (0.160)	-0.353 (0.278)	-0.595*** (0.0804)	-0.343*** (0.0891)
Jobs Under Contract	0.0243** (0.0112)	0.00811 (0.00664)	0.00350 (0.00440)	0.00231 (0.00360)	0.0225** (0.00950)	0.0160* (0.00849)	0.0922*** (0.0296)	0.0898*** (0.0296)	0.00296 (0.00412)	0.00241 (0.00367)
Engineer's Estimate	6.51e-09 (5.12e-09)	2.46e-09 (2.40e-09)	-4.65e-10 (3.30e-09)	2.63e-09 (2.38e-09)	-1.59e-09 (2.21e-09)	-7.19e-10 (1.82e-09)	-2.21e-09 (6.33e-09)	2.75e-10 (6.96e-09)	-8.54e-09 (1.12e-08)	-8.54e-09 (7.60e-09)
Potential Competitors	-0.00299 (0.00382)	-0.00348 (0.00238)	-0.0188*** (0.00492)	-0.0114*** (0.00415)	-0.00405** (0.00197)	-0.00171 (0.00141)	-0.0176 (0.0129)	-0.0149 (0.0127)	-0.0134*** (0.00506)	-0.00315 (0.00393)
One competitive bid proposal purchased	-0.445*** (0.156)	-0.0170 (0.0176)	-0.470*** (0.0552)	-0.189*** (0.0620)	-0.619*** (0.116)	-0.432*** (0.119)	0.0118 (0.0514)	0.00980 (0.0508)	-0.419*** (0.0607)	-0.238*** (0.0469)
Two competitive bid proposals purchased	-0.501*** (0.157)	-0.0552 (0.0353)	-0.510*** (0.0574)	-0.214*** (0.0679)	-0.681*** (0.108)	-0.501*** (0.112)	0 (0)	0 (0)	-0.373*** (0.0744)	-0.251*** (0.0580)
Three or more competitive bid proposals purchased	-0.459*** (0.155)	-0.0215 (0.0218)	-0.632*** (0.0572)	-0.273*** (0.0709)	-0.645*** (0.113)	-0.436*** (0.119)	0.128* (0.0764)	0.105 (0.0781)	-0.366*** (0.0670)	-0.160*** (0.0500)
Project in same county-rival		0.0179 (0.0188)		0.182** (0.0715)					-0.181* (0.108)	
Project in adjacent county-no rival		-0.933*** (0.0471)		-0.380*** (0.0842)		-0.288** (0.111)		-0.330 (0.226)	-0.189*** (0.0625)	
Project in adjacent county-rival		-0.955*** (0.0504)		-0.527*** (0.0793)		-0.371*** (0.110)		-0.401* (0.234)	-0.544*** (0.0708)	
Constant	1.080*** (0.119)	0.990*** (0.0204)	1.488*** (0.0811)	1.278*** (0.0735)	1.091*** (0.0657)	1.048*** (0.0468)	0.724*** (0.200)	0.712*** (0.203)	1.065*** (0.0582)	1.024*** (0.0426)
Observations	146	146	570	570	291	291	131	131	339	339
R-squared	0.674	0.842	0.577	0.692	0.833	0.862	0.332	0.345	0.652	0.740

Table 6.19: Additional regression results for District 4 Firms and firms outside District 4

VARIABLES	Glass Paving			Mago Construction			Nally & Haydon Surfacing			Qualified Paving			Scotty's Contracting and Stone		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.0179 (0.0188)	0.0160 (0.0286)	0.0242 (0.0262)	0.182** (0.0715)	0.143* (0.0767)	0.423*** (0.0733)							-0.181* (0.108)	-0.166 (0.112)	-0.218* (0.114)
Project in adjacent county-no rival	-0.933*** (0.0471)	-0.931*** (0.0526)		-0.380*** (0.0842)	-0.296*** (0.0842)		-0.288** (0.111)	-0.0603 (0.0698)		-0.330 (0.226)	-0.0127 (0.123)		-0.189*** (0.0625)	-0.0616 (0.0731)	
Project in adjacent county-rival	-0.955*** (0.0504)		-0.986*** (0.0879)	-0.527*** (0.0793)		-0.364*** (0.0605)	-0.371*** (0.110)	-1*** (0)		-0.401* (0.234)		-0.207 (0.225)	-0.544*** (0.0708)		-0.648*** (0.106)
Project in adjacent county-Allen Company					-0.314*** (0.0822)			-0.0718 (0.0553)							
Project in adjacent county-ATS Construction					-0.427*** (0.0827)			-0.0783 (0.0522)							
Project in adjacent county-Commercial Pavers		-0.0169 (0.0413)			-0.699*** (0.0842)			-0.0495 (0.0615)		-0.150 (0.139)			-0.407*** (0.0959)		
Project in adjacent county-Gaddie-Shamrock		-0.933*** (0.0619)			-0.480*** (0.0962)			-0.209*** (0.0803)					-0.277*** (0.0814)		
Project in adjacent county-Glass Paving					-0.351*** (0.0814)			-0.0967** (0.0448)		-0.0871 (0.0773)			-0.635*** (0.126)		
Project in adjacent county-HG Mays					-0.383*** (0.0780)			-0.100* (0.0525)							
Project in adjacent county-Hinkle Contracting					-0.384*** (0.0808)			-0.102 (0.0620)							
Project in adjacent county-Lexington Quarry					-0.479*** (0.0857)			-0.112* (0.0580)							
Project in adjacent county-Lincoln County Ready Mix					-0.381*** (0.0650)			-0.129** (0.0588)							
Project in adjacent county-Mago Construction		-0.921*** (0.0545)						-0.163*** (0.0551)		0.127 (0.144)			-0.248** (0.0986)		
Project in adjacent county-Nally & Haydon		-0.960*** (0.0374)			-0.448*** (0.0829)					0.00343 (0.125)			-0.273*** (0.0964)		
Project in adjacent county-Ohio Valley Asphalt					-0.475*** (0.0853)			-0.0525 (0.0581)					-0.272*** (0.0886)		
Project in adjacent county-Qualified Paving		0.0188 (0.0331)			-0.00956 (0.0250)			0.0110 (0.0206)							
Project in adjacent county-Road Builders					-0.381*** (0.0860)					-0.0748 (0.111)			-0.347*** (0.0913)		
Project in adjacent county-Scotty's Contracting		-0.962*** (0.0896)			-0.412*** (0.0833)			-0.0584 (0.0639)		-0.115 (0.0959)					
Project in adjacent county-Shelbyville Asphalt					-0.524*** (0.0943)			-0.0709 (0.0560)					-0.215** (0.100)		
Project in adjacent county-Yager Materials					-0.376*** (0.0822)					-0.0240 (0.115)			-0.538*** (0.0960)		
Project in Larue County			-1.017*** (0.0993)			-0.387*** (0.0613)		-1*** (0)		-0.226 (0.230)					0.0775 (0.0802)
Project in Meade County			-0.963*** (0.0899)			0.484*** (0.0843)		-1*** (0)		-0.393 (0.249)					0.244** (0.102)
Project in Taylor County			-0.995*** (0.0958)			-0.374*** (0.0622)		-0** (0)							-0.635*** (0.109)
Constant	0.990*** (0.0204)	0.999*** (0.0611)	0.972*** (0.0332)	1.278*** (0.0735)	1.264*** (0.0818)	1.227*** (0.0737)	1.048*** (0.0468)	1.037*** (0.0846)	1*** (0)	0.712*** (0.203)	0.773*** (0.228)	0.711*** (0.206)	1.024*** (0.0426)	1.065*** (0.0506)	0.960*** (0.0340)
Observations	146	146	146	570	570	570	291	291	291	131	131	131	339	339	339
R-squared	0.842	0.842	0.848	0.692	0.710	0.773	0.862	0.853	1.000	0.345	0.376	0.386	0.740	0.749	0.849

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.19 (continued)

VARIABLES	Yager Materials (District 2)			Commercial Pavers (District 5)			Flynn Brothers (District 5)			HG Mays (District 5)			Shelbyville Asphalt (District 5)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival										0.128 (0.0996)	0.252** (0.117)	0.218* (0.111)			
Project in adjacent county-no rival	-0.106 (0.105)	-0.107 (0.0948)		-0.764*** (0.116)	-0.737*** (0.107)		-0.0619 (0.407)	-0.115 (0.386)		-0.653*** (0.133)	-0.408*** (0.144)		-0.831*** (0.147)	-0.413*** (0.125)	
Project in adjacent county-rival	-0.329** (0.130)		-0.721*** (0.174)	-0.754*** (0.109)	-0.760*** (0.112)		0.00133 (0.406)	0.00249 (0.410)		-0.729*** (0.133)		-0.374*** (0.128)	-0.836*** (0.146)		-0.836*** (0.148)
Project in adjacent county-Allen Company					-0.751*** (0.119)			-0.166 (0.390)			-0.406*** (0.148)			-0.423*** (0.124)	
Project in adjacent county-ATS Construction					-0.715*** (0.119)						-0.546*** (0.155)			-0.419*** (0.118)	
Project in adjacent county-Commercial Pavers											-0.433*** (0.146)			-0.308** (0.127)	
Project in adjacent county-Gaddie-Shamrock															
Project in adjacent county-Glass Paving					-0.727*** (0.106)			-0.0123 (0.388)							
Project in adjacent county-HG Mays					-0.784*** (0.113)			-0.0168 (0.390)						-0.420*** (0.120)	
Project in adjacent county-Hinkle Contracting											-0.541*** (0.141)			-0.427*** (0.119)	
Project in adjacent county-Lexington Quarry					-0.728*** (0.116)						-0.499*** (0.148)			-0.423*** (0.119)	
Project in adjacent county-Lincoln County Ready Mix											0.0325 (0.0300)				
Project in adjacent county-Mago Construction		-0.346** (0.134)			-0.784*** (0.103)			-0.0554 (0.386)			-0.420*** (0.151)			-0.358*** (0.118)	
Project in adjacent county-Nally & Haydon					-0.763*** (0.104)			-0.0283 (0.387)			-0.360** (0.155)			-0.429*** (0.119)	
Project in adjacent county-Ohio Valley Asphalt					-0.839*** (0.0983)			0.0502 (0.386)			-0.450*** (0.144)			-0.425*** (0.133)	
Project in adjacent county-Qualified Paving		0.213 (0.149)			-0.208 (0.153)			0.118 (0.146)							
Project in adjacent county-Road Builders		-0.213* (0.109)													
Project in adjacent county-Scotty's Contracting		-0.504*** (0.155)			-0.559*** (0.172)			-0.144 (0.389)						-0.385*** (0.131)	
Project in adjacent county-Shelbyville Asphalt					-0.255 (0.156)			-0.0552 (0.404)			-0.396** (0.179)				
Project in adjacent county-Yager Materials															
Project in Larue County						-0.730*** (0.127)			-0.0363 (0.412)						
Project in Meade County						-0.777*** (0.189)			-0.119 (0.413)					-0.834*** (0.141)	
Project in Taylor County						-0.685*** (0.121)									
Constant	1.100*** (0.130)	1.125*** (0.229)	1.153*** (0.118)	0.890*** (0.0841)	0.927*** (0.0953)	0.850*** (0.104)	0.605*** (0.150)	0.560*** (0.166)	0.598*** (0.168)	1.210*** (0.0723)	1.306*** (0.0974)	1.119*** (0.0535)	-0.0875 (0.0973)	-0.0782 (0.180)	-0.0907 (0.109)
Observations	101	101	101	202	202	202	165	165	165	373	373	373	214	214	214
R-squared	0.805	0.823	0.916	0.663	0.716	0.665	0.435	0.445	0.436	0.667	0.665	0.764	0.695	0.453	0.695

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.19 (continued)

VARIABLES	The Allen Company (District 7)			Lexington Quarry (District 7)			Lincoln County Ready Mix (District 7)			Gaddie-Shamrock (District 8)			Hinkle Contracting (District 8)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)												
Project in adjacent county-no rival	-0.177*** (0.0637)	-0.142** (0.0576)		-0.177 (0.195)	0.0911 (0.259)		-0.330* (0.183)	-0.341* (0.185)		-0.158 (0.112)	-0.0981 (0.0845)		-0.277*** (0.0693)	-0.244*** (0.0650)	
Project in adjacent county-rival	-0.424*** (0.0671)		-1*** (0)	-0.254 (0.192)	-0.283 (0.195)		-0.540*** (0.187)	-0.739*** (0.224)		-0.200* (0.116)	-0.669*** (0.232)		-0.356*** (0.0769)		-0.683*** (0.111)
Project in adjacent county-Allen Company					0.0637 (0.259)			-0.284 (0.226)			-0.112 (0.0958)			-0.341*** (0.0759)	
Project in adjacent county-ATS Construction		-0.678*** (0.0720)			-0.278 (0.198)			-0.503*** (0.190)						-0.391*** (0.0843)	
Project in adjacent county-Commercial Pavers															
Project in adjacent county-Gaddie-Shamrock		-0.275*** (0.0625)						-0.487*** (0.187)						-0.318*** (0.0719)	
Project in adjacent county-Glass Paving											-0.0714 (0.0905)				
Project in adjacent county-HG Mays		-0.244*** (0.0645)			0.00508 (0.265)			-0.387* (0.200)						-0.318*** (0.0726)	
Project in adjacent county-Hinkle Contracting		-0.385*** (0.0683)			0.0761 (0.259)			-0.570*** (0.190)			-0.116 (0.0723)				
Project in adjacent county-Lexington Quarry		-0.445*** (0.0693)						-0.809*** (0.204)						-0.328*** (0.0749)	
Project in adjacent county-Lincoln County Ready Mix					-0.0451 (0.0456)									0.0488* (0.0251)	
Project in adjacent county-Mago Construction		-0.331*** (0.0765)			0.0270 (0.261)			-0.540*** (0.194)			-0.157* (0.0863)			-0.300*** (0.0706)	
Project in adjacent county-Nally & Haydon		-0.307*** (0.0640)			0.0317 (0.264)			-0.652*** (0.197)			-0.152* (0.0892)			-0.282*** (0.0697)	
Project in adjacent county-Ohio Valley Asphalt															
Project in adjacent county-Qualified Paving															
Project in adjacent county-Road Builders															
Project in adjacent county-Scotty's Contracting											-0.0608 (0.0430)				
Project in adjacent county-Shelbyville Asphalt		-0.227*** (0.0787)			0.0370 (0.264)			-0.442** (0.194)						-0.236*** (0.0679)	
Project in adjacent county-Yager Materials															
Project in Larue County												-0.638** (0.251)			
Project in Meade County															
Project in Taylor County			-1*** (0)					-0.765*** (0.223)			-0.746*** (0.184)			-0.686*** (0.113)	
Constant	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)	0.975*** (0.107)	0.936*** (0.163)	1.133*** (0.0930)	0.947*** (0.190)	1.042*** (0.228)	0.859*** (0.190)	1.096*** (0.0679)	1.064*** (0.0633)	0.979*** (0.0263)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)
Observations	336	336	336	239	239	239	229	229	229	142	142	142	531	531	531
R-squared	0.788	0.834	1.000	0.702	0.739	0.852	0.473	0.538	0.668	0.866	0.864	0.973	0.892	0.893	0.942

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

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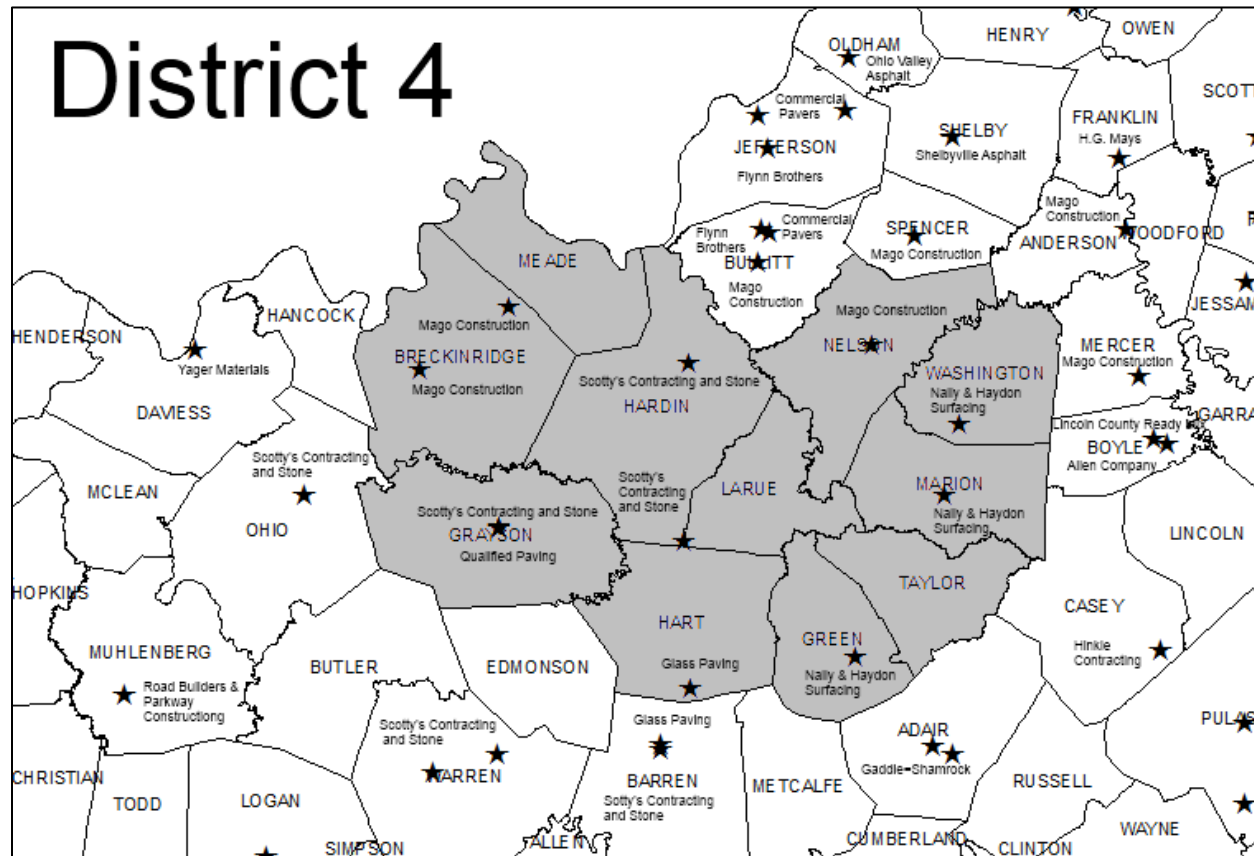


Figure 6.15: Glass Paving Service Area

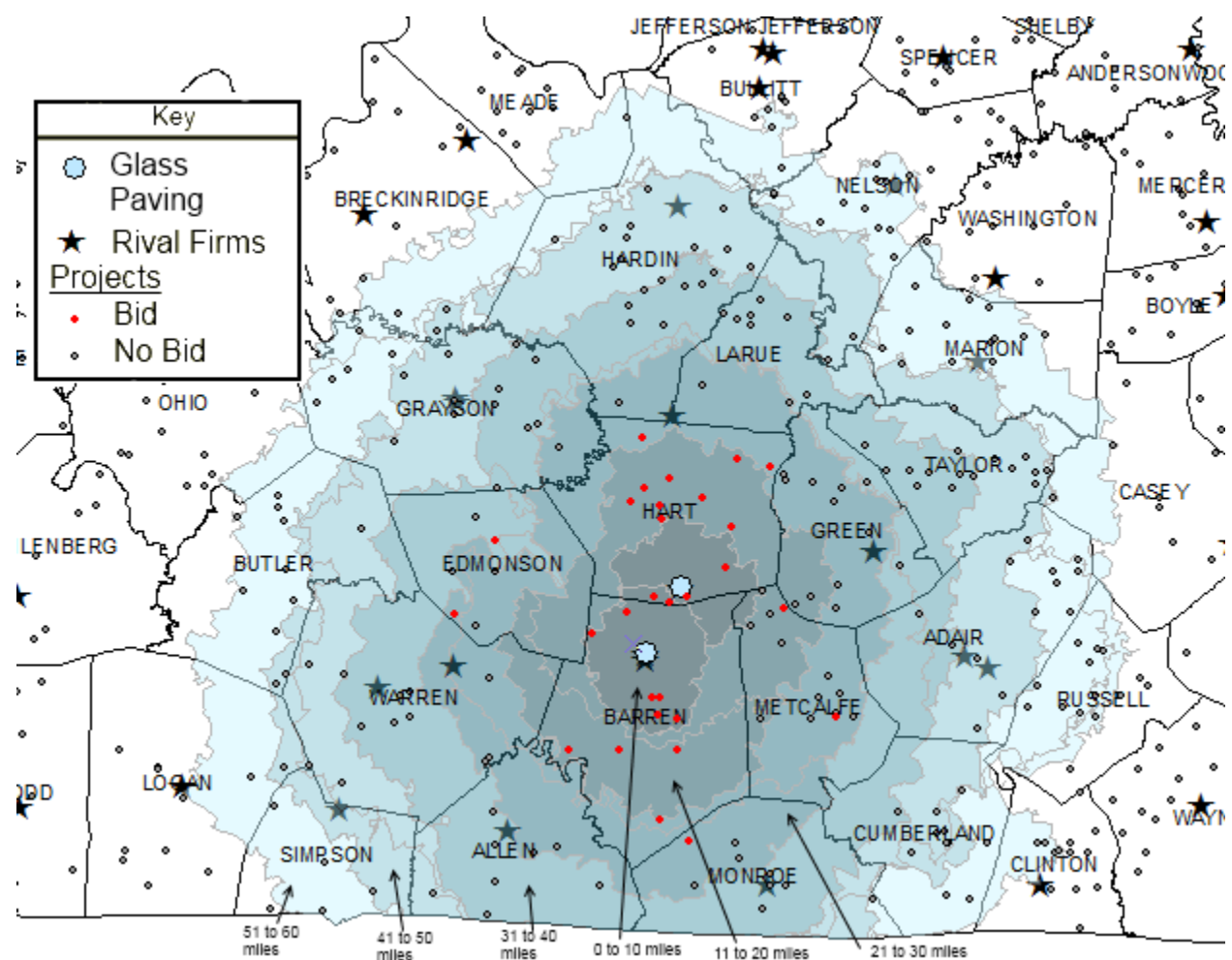


Figure 6.16: Mago Construction Service Area

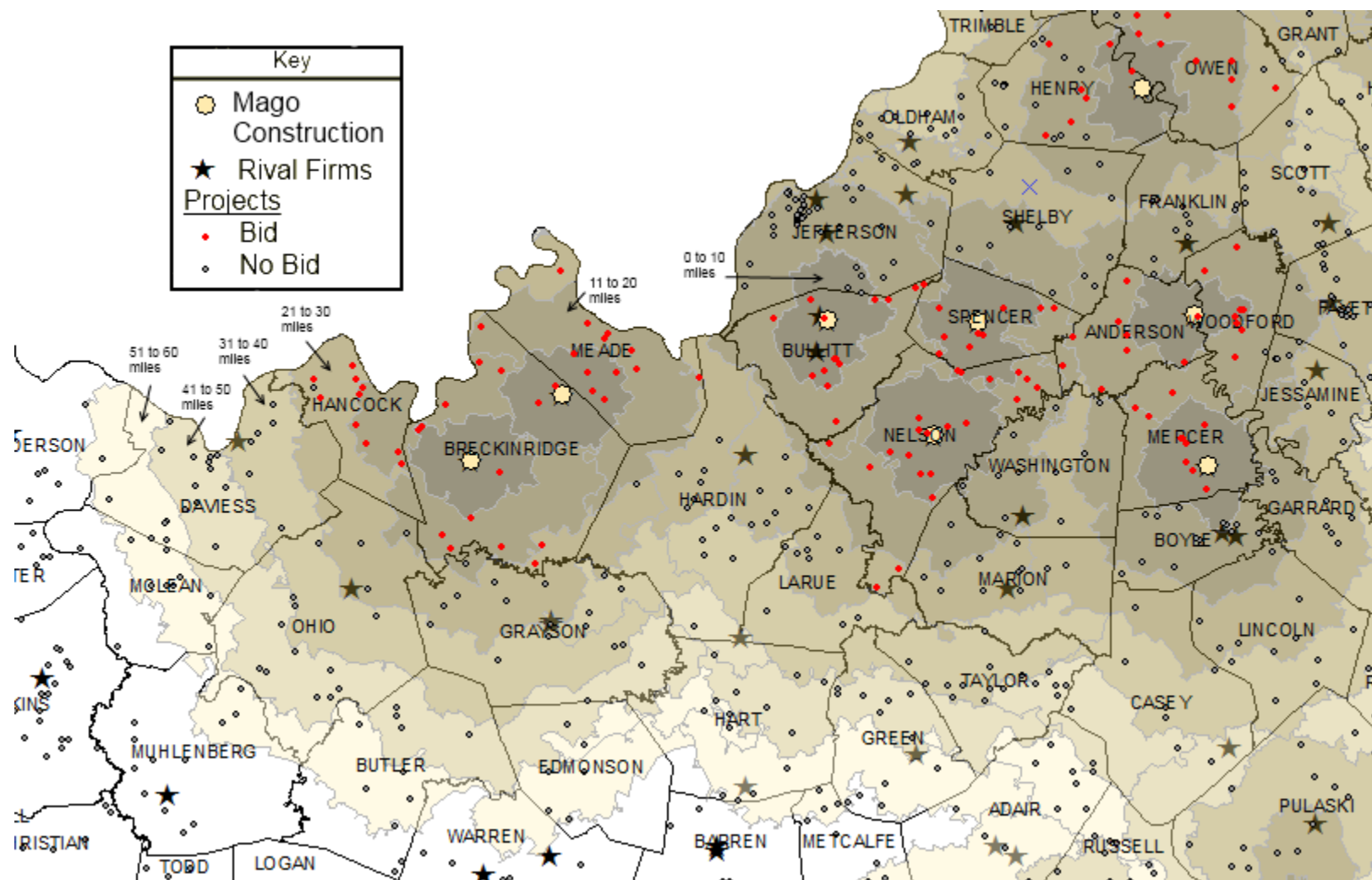


Figure 6.17: Nally & Haydon Surfacing Service Area

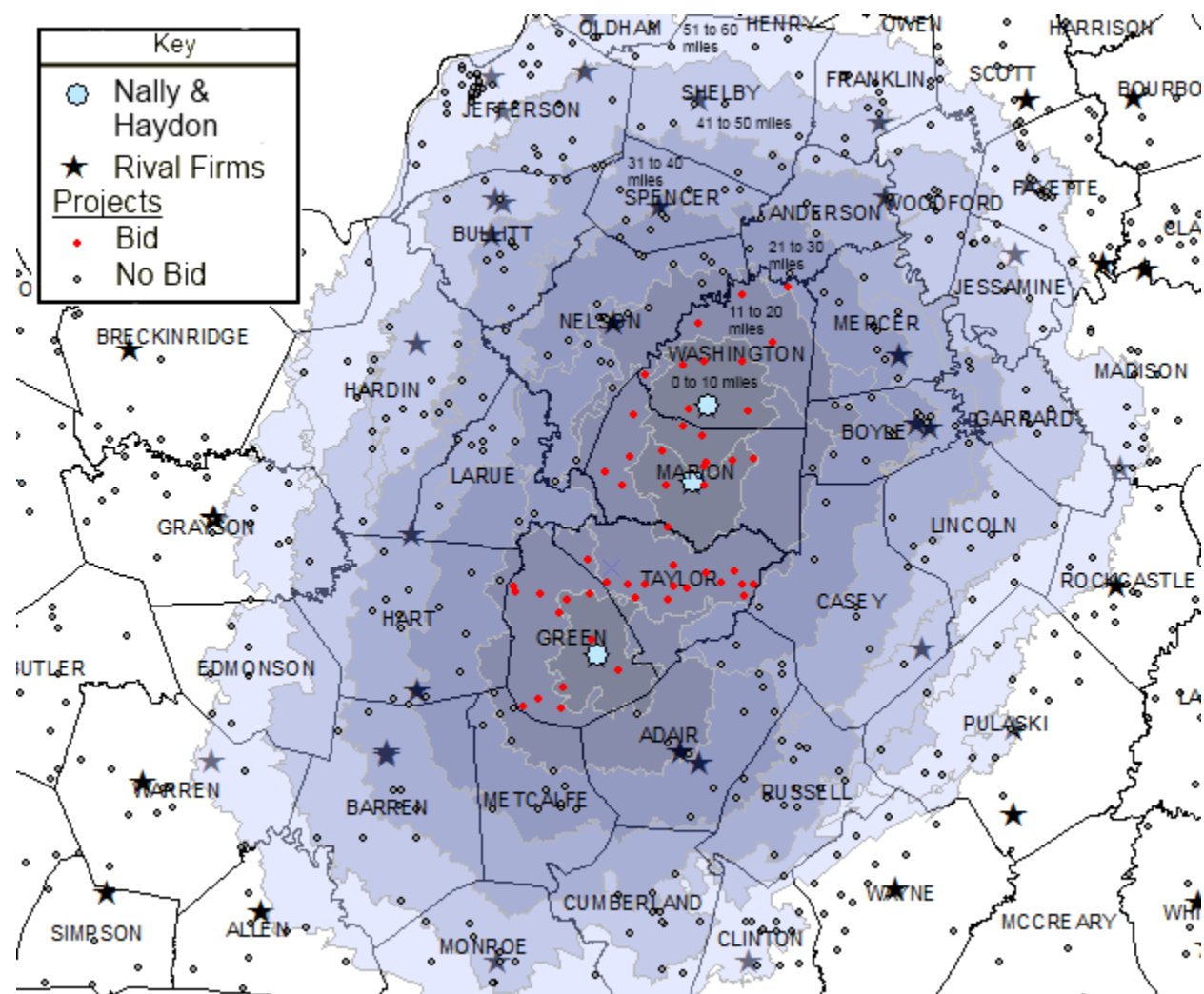


Figure 6.18: Qualified Paving Service Area

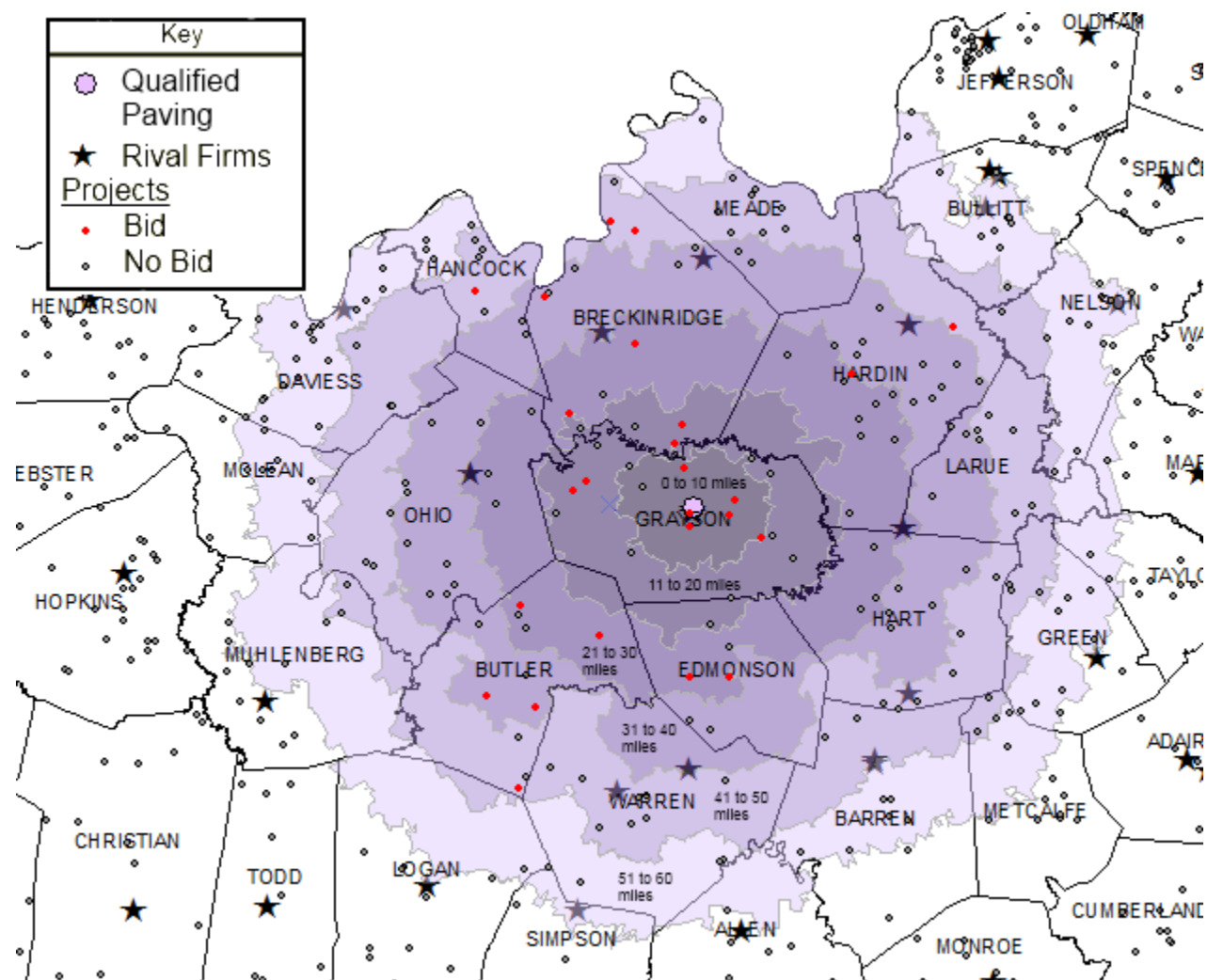
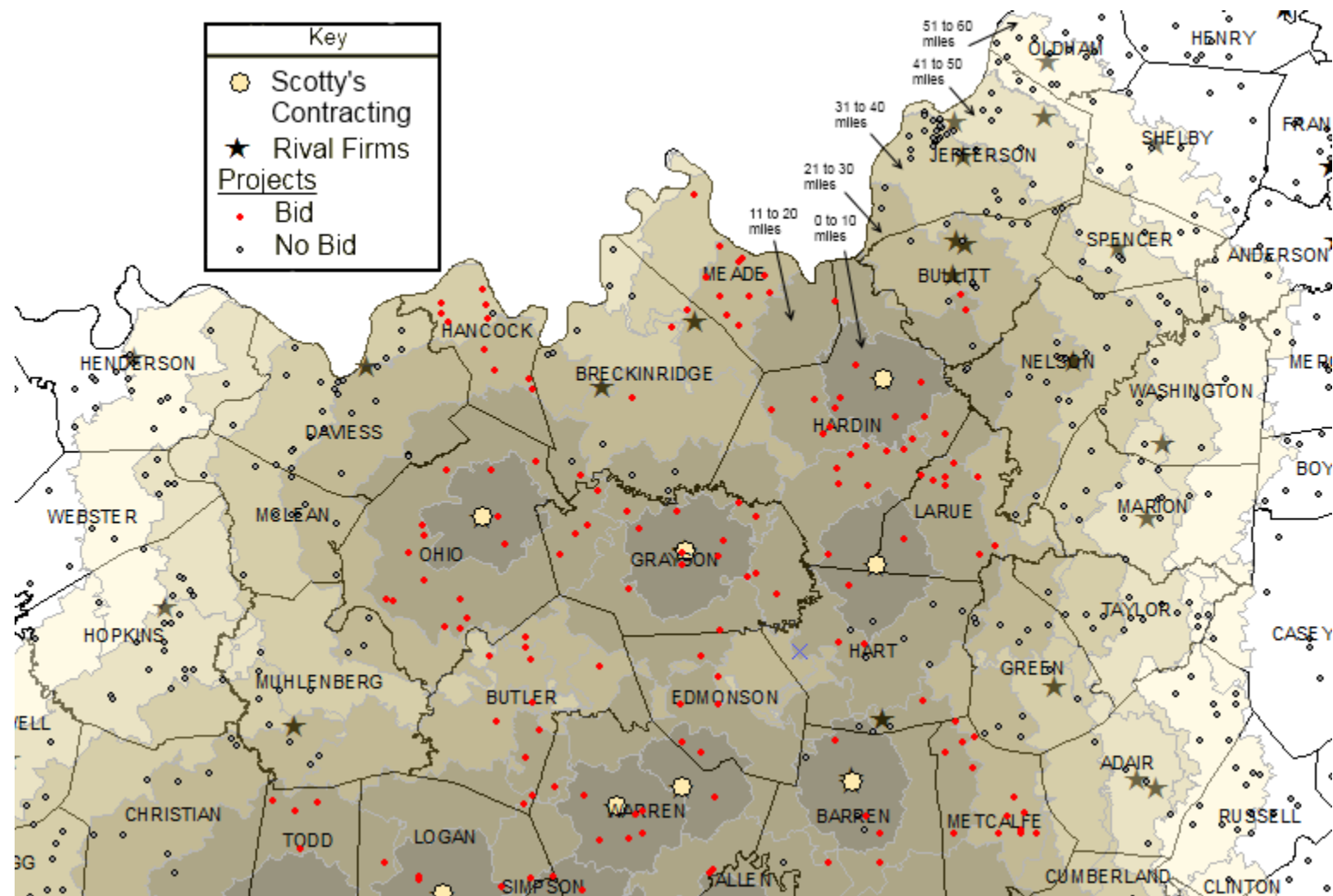


Figure 6.19: Scotty's Contracting and Stone Service Area



6.6 District 5 – Louisville Area

District 5 consists of firms in the Louisville area of Kentucky (see Figure 6.20). There are six firms that have plants located in this district and that compete on projects: Commercial Pavers, Flynn Brothers, H.G. Mays, Mago Construction, Ohio Valley Asphalt, and Shelbyville Asphalt. There are also Gohmann Asphalt and Mac Construction from Indiana that are active bidders in this district. There are many firms outside District 5 that are within a reasonable distance to bid on projects in a county. There is evidence that firms avoid bidding against other firms in every county in the district. While this is tacit collusion, in four counties this coordination of bids has little or no impact on bid levels. Only in Franklin County and Trimble County does tacit collusion result in all projects having only one bidder. There is evidence of collusive behaviors between firms which results in firms being less likely to bid in a county where a rival firm has an asphalt plant. The actual impact on bid levels is low except in Franklin, Trimble and Henry Counties, and single-bid contracts are \$884,582.35 above the competitive level.

Bullitt, Jefferson, Oldham, Spencer, and Shelby Counties have multiple bidders. The avoidance of bidding is probably due to the fierce competition and low bid levels, and less about firms engaging in a tit-for-tat strategy. Projects average 13.34 percent below the engineer's estimate which is well below the Kentucky average of 3.84 percent below the engineer's estimate. These counties are extremely competitive and the fact that a firm does not bid against a rival firm could simply be because the bid levels are too low. The fact that bid levels were not impacted by a firm's refusal to bid, indicates the strategic part of bidding is not very important on a lot of the projects in these counties. This is especially true in Bullitt, Jefferson, Oldham, and Shelby Counties. This is very important to remember as the results are explained in this section. An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.20, Table 6.21, Table 6.22, and Table 6.23. A map for the firms follows the tables. The additional regression results found in Table 6.23 includes all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.6.1 *Firms with Asphalt Plants in District 5*

COMMERCIAL PAVERS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Commercial Pavers has three asphalt plants located in District 5 in Bullitt and Jefferson Counties. Their primary competitors who have asphalt plants in these counties are Flynn Brothers and Mago Construction. Other competitors include Indiana firms Gohmann Asphalt and Mac Construction along with Kentucky firms Ohio Valley Asphalt and Scotty's Contracting. They bid on 53 projects in Kentucky. Seven of these projects are in District 4 (Hardin and Meade Counties) and the other 46 are in District 5. They were awarded 24 of the 53 projects. The contracted value of all of the 53 projects was \$36,580,013.05. The average number of bidders on these projects was 3.43 bids. There are no single-bid contracts on any of these projects. The 53 projects average 16.23 percent below the engineer's estimate. This is a very competitive area of Kentucky and this competition puts downward pressure on bids.

FIRM BID FUNCTION

The bid function for Commercial Pavers is in Table 6.22. Without the county variables (A), it indicates that once a project gets beyond 10 miles, the probability of Commercial Pavers bidding on a project diminishes significantly. However, when the county variables are added in specification (B) the coefficients on distance from 11 to 20 miles and 21 to 30 miles become positive. This means that Commercial Pavers is more likely to bid on projects in these distances than projects 0 to 10 miles from their asphalt plant. In Figure 6.21 it shows that most of the projects Commercial Pavers bids on are located near their asphalt plants. Another interesting result when the county variables are added, the "Jobs Under Contract" is significant and negative. They are less likely to bid on a project the more projects they are contracted to complete. They are less likely to bid on projects when other firms purchase bid proposals.

When the county variables are added, the adjacent county variables are negative and significant. The magnitude for both variables is very high. This means when all other variables are controlled for they are less likely to bid on projects in counties adjacent to Bullitt and Jefferson Counties. What may be happening is that since a majority of the projects they bid on are in Bullitt and Jefferson Counties, the actual distinction of whether they bid on a project is more in line with county boundaries than it is with distances. They primarily bid in these two counties and when the counties are controlled for in the regression the distance variables are

less important. In the additional regressions in Table 6.23, they are less likely to bid on projects in counties where these firms have asphalt plants. They are also less likely to bid on projects in Trimble County than on projects in Bullitt and Jefferson Counties. From these two results, it emphasizes the point that they bid primarily in Bullitt and Jefferson Counties. More of their bidding behavior will be explored in the “Counties” section.

FLYNN BROTHERS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Flynn Brothers has two plants located in District 5 located in Bullitt and Jefferson Counties. Their primary competitors who have asphalt plants in these counties are Commercial Pavers and Mago Construction. Other competitors include Indiana firms Gohmann Asphalt and Mac Construction along with Kentucky firms Ohio Valley Asphalt and Scotty’s Contracting. They bid on 31 projects in Kentucky and all of them are in District 5 counties. They were awarded six of the 31 projects. The contracted value of all of the 31 projects was \$11,793,201.38. The average number of bidders on these projects was 3.74 bids. There were no single-bid contracts on any of these projects. The 31 projects average 16.89 percent below the engineer’s estimate. This is a very competitive area of Kentucky and this competition puts downward pressure on bids.

FIRM BID FUNCTION

The bid function for Flynn Brothers is in Table 6.22. Without the county variables (A), it indicates that once a project gets beyond 20 miles, the probability of Flynn Brothers bidding on a project diminishes significantly. The farther a project is away the less likely they are to bid on that project. The distance variables are not significant when the county variables are added. The “Engineer’s Estimate” variable indicates they are less likely to bid on projects the more the dollar value increases. They are also less likely to bid on a project if another competitor has purchased a bid proposal as compared to when two or more competitors have purchased a bid proposal. This is because most projects have two or more firms purchasing bid proposals. The county variables are not significant. This means that projects outside Bullitt and Jefferson Counties have an equal chance of being bid on by Flynn Brothers. The main driver behind their bidding is the size of the project. In the additional regressions in Table 6.23, when the specific firms are added in specification (C) there are no significant results. The location of the project in

a particular county is not a concern to Flynn Brothers. More of their bidding behavior will be explored in the “Counties” section.

H.G. MAYS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

H.G. Mays has one of their three plants located in Franklin County in District 5. Their primary competitors in District 5 are Mago Construction and Shelbyville Asphalt. In District 7 near Franklin County, Nally & Gibson Georgetown has a plant located in Scott County, and ATS Construction has a plant located in Fayette County and both are potential competitors. H.G. Mays bid on 38 projects in Kentucky and 10 of those are in counties in District 5. The rest of the projects are in District 9. They were awarded contracts on all 10 bids. The contracted value of all of the 10 projects was \$5,044,535.41. The average number of bidders on these projects was 1.20 bids. Nine of the 10 bids only had one bidder, H.G. Mays, and the contracted value of these projects was \$2,956,437.61, and the projects were all located in Franklin County. The contracted value of these nine single-bid contracts averaged 2.20 percent above the engineer’s estimate. The other project was located in Shelby County and two other firms bid on the project. The contracted value of the project was 25.48 percent below the engineer’s estimate. Unlike Commercial Pavers and Flynn Brothers, H.G. Mays faces no competition in Franklin County. The nature of this competition will be looked at more in-depth in the “Counties” section below.

FIRM BID FUNCTION

The bid function for H.G. Mays is in Table 6.22. Without the county variables (A), it indicates that once a project gets beyond 10 miles, the probability of H.G. Mays bidding on a project diminishes significantly. This result changes when the county variables are added and none of the distance variables are significant. As the number of potential competitors increases for a project they are less likely to bid on a project. Competitors purchasing bid proposals also makes it less likely that H.G. Mays will bid on a project. This is not significant when the county variables are added in specification B. The county variables indicate that H.G. Mays is less likely to bid on projects in adjacent counties. The magnitude is stronger when a rival has an asphalt plant in the adjacent county. When specific firms are added in Table 6.23, they are less likely to bid on projects in all these counties with the exception of Boyle County where Lincoln County Ready Mix has a plant. A picture emerges where H.G. Mays primarily bids on projects in the counties where they have asphalt plants and avoids bidding on projects in counties where rival

firms have asphalt plants. More of their bidding behavior will be explored in the “Counties” section.

MAGO CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mago Construction has three of their 12 plants located in District 5. There are plants located in Bullitt, Henry, and Spencer Counties. Their primary competitors, who have asphalt plants in these counties, are Commercial Pavers and Flynn Brothers. Other competitors include Indiana firms Gohmann Asphalt and Mac Construction along with Kentucky firms Ohio Valley Asphalt and Scotty’s Contracting. They bid on 102 projects in Kentucky and 19 of those are in counties in District 5. Of those 19 bids, they were awarded 16 of the contracts. The contracted value of all of the 19 projects was \$5,781,493.61. The average number of bidders on these projects was 2.16 bids. Seven of the 19 bids only had one bidder, Mago Construction, and the contracted value of these projects was \$1,444,070.50. These projects are located in Henry and Spencer Counties. The contracted value of these seven single-bid contracts averaged 5.92 percent below the engineer’s estimate. For the other 12 projects with more than one bidder, the contracted value of the projects averages 16.83 percent below the engineer’s estimate. What is interesting about these numbers is that the single-bid contracts have percentages lower than is typical. This could indicate that Mago Construction is facing a competitive environment with the threat of bidding from other firms. This puts downward pressure on the bids. The nature of this competition will be looked at more in-depth in the “Counties” section below. As shown above, this threat of bidding by other firms puts downward pressure on the bids.

FIRM BID FUNCTION

The results of the bid function for Mago Construction were discussed in detail in the District 4 section. The important points of the bid function will be highlighted here. The county variables indicate that Mago Construction is less likely to bid on a project in adjacent counties than on projects in the counties where they have asphalt plants. Distance, competitor behavior, and which county a project is located in all significantly influence whether or not Mago Construction bids on a project. More of their bidding behavior will be explored in the “Counties” section.

OHIO VALLEY ASPHALT

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Ohio Valley Asphalt has one asphalt plant located in District 5 in Oldham County. Their primary competitors located in District 5 are Commercial Pavers, Flynn Brothers, and Mago Construction. Other competitors include Indiana firms Gohmann Asphalt and Mac Construction along with Kentucky firm Shelbyville Asphalt. Ohio Valley Asphalt bid on 33 projects in Kentucky, and 20 of those projects are in District 5. The contracted value of the 20 projects was \$5,868,435.46. The average number of bidders on these projects was 2.25 bids. Only five of the 20 bids had one bidder. The contracted value of these five single-bid contracts averaged 0.65 percent above the engineer's estimate. For the one project with two bidders, the contracted value of the projects was 13.90 percent below the engineer's estimate.

FIRM BID FUNCTION

The bid function for Ohio Valley Asphalt is in Table 6.22. Without the county variables (A), once a project gets beyond 10 miles, the probability of Ohio Valley Asphalt bidding on a project diminishes significantly. However, when the county variables are added then it extends to beyond 40 miles when they are less likely to bid on a project at a significant level. If a rival firm purchases a bid proposal, Ohio Valley Asphalt is less likely to bid on a project in both specifications. The county variables also significantly impacted whether or not they bid on a project. They are less likely to bid on a project if it is in an adjacent county to Oldham and Carroll Counties. When variables are added for specific firms it indicates they are less likely to bid on projects where Commercial Pavers and Flynn Brothers have asphalt plants and where Eaton Asphalt Paving has asphalt plants. Other than that the other variables explain why they do not bid on the projects against the other firms. More of their bidding behavior will be explored in the "Counties" section.

SHELBYVILLE ASPHALT

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Shelbyville Asphalt has one asphalt plant located in Shelby County. Their primary competitors located in District 5 are Commercial Pavers, Flynn Brothers, and Mago Construction. Other competitors include Indiana firms Gohmann Asphalt and Mac Construction along with Kentucky firms H.G. Mays and Ohio Valley Asphalt. They bid on six projects in District 5. They were awarded three of those six contracts. The contracted value of all of the six projects was

\$1,833,478.40. The average number of bidders on these projects was 2.33 bids. Only one project had one bidder. The contracted value of these six contracts averaged 17.56 percent below the engineer's estimate. There is a lot of competition and this puts downward pressure on prices.

FIRM BID FUNCTION

The bid function for Shelbyville Asphalt is in Table 6.22. The results of the regression may be suspect due to lack of variation since they only bid on six projects. When the county variables are added to the regression all of the distance variables are very significant and positive. The interpretation of this is that they are more likely to bid on projects if it is further than 10 miles from their plant. The county variable indicates they are less likely to bid on projects outside Shelby County where they have their asphalt plant which supports their bidding pattern. They only bid on one project that is outside Shelby County and this is confirmed when specific firms are added in Table 6.23. More of their bidding behavior will be explored in the "Counties" section.

6.6.2 Counties in District 5

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.23). The additional regressions for firms outside District 5 will be discussed and can be found in Table 6.23. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.22). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

TRIMBLE COUNTY

There are a total of three projects in Trimble County. The total contracted value of these projects is \$995,953.00. The project's contracted value averages 0.59 percent below the engineer's estimate. The competitive average for all of District 5 is 15.67 percent below the engineer's estimate (see Table 6.20). Ohio Valley Asphalt is the major firm that bid on these

three projects. The other firms that are potential competitors include Commercial Pavers, Flynn Brothers, Mago Construction, Shelbyville Asphalt, H.G. Mays, Eaton Asphalt Paving (District 6), Bluegrass Paving (District 6), and Barrett Paving (District 6). These firms had a variable for Trimble County added in to the additional regressions. Of these firms Commercial Pavers, H.G. Mays, Mago Construction, Shelbyville Asphalt, Barrett Paving (District 6) and Eaton Asphalt Paving (District 6) have a negative and significant coefficient for Trimble County (see Table 6.23). To see if there is tacit collusion it is important to look at the Ohio Valley Asphalt additional regressions in Table 6.23 specification C. There is evidence of only two firms where Ohio Valley Asphalt avoids bidding in their counties: Commercial Pavers and Eaton Asphalt Paving. These firms do not bid in Trimble County and Ohio Valley Asphalt in turn does not bid in Jefferson or Bullitt County and Gallatin County. The impact of this tacit collusion is that bids are above the competitive level for District 5 by \$150,189.71.

COUNTIES WITH ASPHALT PLANTS

BULLITT AND JEFFERSON COUNTIES

Jefferson County is where the city of Louisville, Kentucky is located. This urban setting provides more opportunities for projects and as a result there are more firms located in this area. In Bullitt County, Commercial Pavers, Flynn Brothers, and Mago Construction have asphalt plants. Commercial Pavers and Flynn Brothers also have plants in Jefferson County. Other firms that bid on projects in these counties include Indiana firms Gohmann Asphalt and Mac Construction along with Kentucky firm Ohio Valley Asphalt. The bidding behavior in each county will be examined separately.

In Bullitt County, there are 6 projects with a contracted value of \$1,847,832.90. Commercial Pavers, Flynn Brothers and Mago Construction have asphalt plants in Bullitt County and Gohmann Asphalt (Indiana) and Scotty's Contracting (District 4) bid on projects. This fierce competition puts downward pressure on the projects which results in the average for projects in Bullitt County being 18.11 percent below the engineer's estimate. The six projects average 3.33 bidders per project. The potential competitors in Bullitt County include the firms listed previously along with Ohio Valley Asphalt, Shelbyville Asphalt, and Nally & Haydon Surfacing (District 4). Ohio Valley Asphalt is less likely to bid on projects in counties where Commercial Pavers has an asphalt plant and this avoidance of bidding is returned by Commercial Pavers (see

Table 6.23). While Ohio Valley Asphalt does not bid on projects in Jefferson or Bullitt Counties, Commercial Pavers did bid on one project with multiple components in Oldham County (see Figure 6.21 and Figure 6.25). This is also the case for Commercial Pavers with Shelbyville Asphalt (see Table 6.23). There is also evidence of Commercial Pavers and Scotty's Contracting avoiding bidding in each other's counties. Scotty's Contracting only bids on one project in Bullitt County. There is no evidence of tacit collusion between Commercial Pavers and Nally & Haydon Surfacing. Table 6.23 indicates that there is no tacit collusion between Flynn Brothers and any of the other firms.

Shelbyville Asphalt is less likely to bid on projects where Mago Construction has an asphalt plant and vice versa (see Table 6.23). As detailed in District 4, Nally & Haydon Surfacing and Mago Construction avoid bidding in each other's counties as do Scotty's Contracting and Mago Construction. With all this being said, this tacit collusion does not significantly impact bids. The results that come from the statistical analysis are likely showing the fact that bidding in Bullitt County is so competitive that some firms avoid bidding. This is particularly true with Commercial Pavers and Ohio Valley Asphalt. Their avoidance in Bullitt County and Oldham County seems more to do with the level of competition than trying to drive bids up. There is so much competition that bid levels are very low compared to the District 5 average. While there is evidence of that firms avoid bidding in Bullitt County, it has a negligible impact on bid levels.

In Jefferson County, only Commercial Pavers and Flynn Brothers have asphalt plants. With over \$31 million worth of projects spread over 32 projects, other firms such as Indiana firms Gohmann Asphalt and Mac Construction bid on the projects. The projects average 12.61 percent below the engineer's estimate, and each project averages 3.41 bidders. Only three jobs have one bidder. The potential Kentucky competitors in Jefferson County beside Commercial Pavers and Flynn Brothers include Mago Construction, Ohio Valley Asphalt, Shelbyville Asphalt, Scotty's Contracting, and Nally & Haydon Surfacing. There is no evidence of tacit collusion between Flynn Brothers and any of the other firms. As noted in Bullitt County, there is evidence of tacit collusion between Ohio Valley Asphalt and Commercial Pavers as well as between Commercial Pavers and Shelbyville Asphalt. Mago Construction is less likely to bid in Jefferson County and Commercial Pavers is less likely to bid on projects in counties where Mago Construction has their asphalt plants (see Table 6.23). In Figure 6.21, Commercial Pavers bids on projects in Spencer County but not in Nelson County where Mago Construction has their asphalt

plants. There is also evidence of Commercial Pavers and Scotty's Contracting avoiding bidding in each other's counties. There is no evidence of tacit collusion between Commercial Pavers and Nally & Haydon Surfacing.

What appears to be happening is that, like Bullitt County, outside firms see the fierce competition and choose not bid in Jefferson County. They would probably lose money if they bid on and won the project. Like Bullitt County, this tacit collusion does not impact the bid levels for the single-bid contracts since Gohmann Asphalt is the lone bidder. This refusal to bid on the part of the firms outside Jefferson County does not increase bid levels above the competitive level.

FRANKLIN COUNTY

H.G. Mays has an asphalt plant in Franklin County. There are nine projects in Franklin County with a contracted value of is \$2,956,437.61, which averages 2.02 percent above the engineer's estimate. The competitive average for projects in District 5 is 15.67 percent below the engineer's estimate. H.G. Mays is the only bidder on all nine projects.

The fact that no other firm bid on projects in Franklin County could indicate there is tacit collusion. The firms that reasonably could bid on the projects in Franklin County besides H.G. Mays include Commercial Pavers, Flynn Brothers, Mago Construction, Ohio Valley Asphalt, Shelbyville Asphalt, Nally & Haydon Surfacing (District 4), Eaton Asphalt Paving (District 6), The Allen Company (District 7), ATS Construction (District 7), Hinkle Contracting (District 7), Lexington Quarry (District 7), Lincoln County Ready Mix (District 7), and Nally & Gibson Georgetown (District 7). Of these 13 potential competitors, there is evidence that ten of them are tacitly colluding with H.G. Mays on projects in Franklin County. It may seem unreasonable that this many firms could coordinate their bids. One of the factors driving this is that the tacit collusion is marked by a refusal to bid. If all of the firms refuse to bid in each other's counties then this type of coordination can accommodate a large number of firms. In the additional regressions, a variable for adjacent county projects in counties where H.G. Mays has an asphalt plant was included in the regressions for these firms (see Table 6.23). Table 6.23 shows that H.G. Mays avoids bidding against the ten firms in counties where they have asphalt plants. The firms where there is no evidence of tacit collusion include ATS Construction, Flynn Brothers, Lexington Quarry, Lincoln County Ready Mix, and Ohio Valley Asphalt.

Figure 6.23 shows the bidding pattern for H.G. Mays. They seldom venture beyond Franklin County and no other firms bid on projects in Franklin County. This includes Mago Construction (Anderson County) and Nally & Gibson Georgetown (Scott County) in neighboring counties. The other eight firms have 60 miles service areas that overlap all of the projects in Franklin County. In summary, there is evidence of tacit collusion between H.G. Mays and eight other firms. The refusal to bid by these firms allows H.G. Mays to be the only bidder in the county which increases bid levels over the competitive level. This result highlights the difference that was occurring in Bullitt and Jefferson County and what is happening in Franklin County. In Franklin County the fact that firms do not bid against H.G. Mays results in H.G. Mays winning all of the projects. Due to the tacit collusion, H.G. Mays is acting like a monopolist and is able to increase the price above the competitive level. This coordination of bids results in bid levels that are \$528,315.40 above the competitive level.

HENRY AND SPENCER COUNTIES

In these two counties, Mago Construction has asphalt plants. There are 19 projects in these counties. The contracted value of these projects is \$5,584,333.21. Of these 19 projects, nine of them are single-bid projects which average 4.05 percent below the engineer's estimate. The average for the other 10 projects in these counties is 14.63 percent below the engineer's estimate.

The firms that bid on the 12 projects in Henry County besides Mago Construction are Flynn Brothers, Gohmann Asphalt, Ohio Valley Asphalt, and Shelbyville Asphalt. However, half of the projects only have one bidder. The interesting fact is that Mago Construction and Ohio Valley Asphalt are the firms that are awarded contracts on the single-bid projects. There does not appear to be any pattern or behavior that indicates agreement on who bids on which project. Only on two of the 12 projects do Ohio Valley Asphalt and Mago Construction actually bid against each other. The other potential competitors include Commercial Pavers, H.G. Mays, Barrett Paving (District 6), Eaton Asphalt Paving (District 6), ATS Construction (District 7), and Nally & Gibson Georgetown (District 7). There is evidence of tacit collusion between Mago Construction and ATS Construction, Barrett Paving, Commercial Pavers, Eaton Asphalt Paving, H.G. Mays, and Nally & Gibson Georgetown. These firms have all the projects in Henry County within their 60 mile service area, but are less likely to bid on the projects when distance and the other factors are controlled. In turn Mago Construction is less likely to bid on projects in these

firm's counties. One thing that must be noted is that at times Ohio Valley Asphalt is the only bidder of the projects. The firms where there is evidence of tacit collusion with Ohio Valley Asphalt include Commercial Pavers and Eaton Asphalt Paving. In conclusion there are six firms that tacitly collude with Mago Construction and two firms that collude with Ohio Valley asphalt. There is no evidence that Mago Construction and Ohio Valley Asphalt collude with each other. This collusion results in single-bid contracts that are \$176,357.77 above the competitive level for District 5.

There are seven projects in Spencer County. Mago Construction has an asphalt plant and bids on the seven projects. The other firms that bid in Spencer County are Commercial Pavers, Flynn Brothers, and Gohmann Asphalt. The potential bidders in Spencer County include District 5 firms Commercial Pavers, Flynn Brothers, H.G. Mays, Mago Construction and Shelbyville Asphalt along with Scotty's Contracting (District 4), Nally & Haydon Surfacing (District 4), The Allen Company (District 7), and Lincoln County Ready Mix (District 7). There is evidence that seven of the potential competitors are tacitly colluding with Mago Construction including Commercial Pavers, H.G. Mays, Shelbyville Asphalt, Scotty's Contracting, Nally & Haydon Surfacing, The Allen Company, and Lincoln County Ready Mix (see Table 6.23). These firms are less likely to bid on projects in counties where Mago Construction has asphalt plants and Mago Construction returns the favor. Even with this said there is competition from Commercial Pavers, Flynn Brothers, and Gohmann Asphalt. Commercial Pavers bids against Mago Construction in Spencer County yet there is strong evidence that they avoid each other's counties (see Figure 6.21). This competition puts downward pressure on bids, and even the single-bid contracts average well below the engineer's estimate (see Table 6.20). Since the other firms do not bid on the projects there are single-bid contracts. These single-bid contracts are only \$25,226.56 above the competitive level for District 5.

OLDHAM COUNTY

Oldham County is located next to Louisville, Kentucky. Ohio Valley Asphalt has an asphalt plant in Oldham County. There are a total of 9 projects in Oldham County and these projects average 16.29 percent below the engineer's estimate. The average number of bidders on a project is 3.11. Like the neighboring counties, Oldham County is a place where many firms compete for the projects. These firms include Commercial Pavers and Flynn Brothers located with plants in Jefferson County. Also Indiana firms Gohmann Asphalt and Mac Construction bid

on projects. The other potential competitors in Oldham County that do not bid on projects include H.G. Mays, Mago Construction, and Shelbyville Asphalt. There is only evidence of tacit collusion between Ohio Valley Asphalt and Commercial Pavers (see Table 6.23). These results have been discussed in the Jefferson County section. Commercial Pavers only bid on one project in Oldham County. The fact that these two firms do not bid against each other is probably a result of the competitive nature of the area and less about trying to increase profits. The effect of the tacit collusion between these two firms does not significantly impact bid levels.

SHELBY COUNTY

Shelby County is also a county where many firms bid on the eight projects. Shelbyville Asphalt has a plant in Shelby County, however they do not bid on projects in a consistent manner. Some additional firms that bid on projects in Shelby County include Certified Construction, Commercial Pavers, Flynn Brothers, H.G. Mays, Mago Construction and Indiana firms Gohmann Asphalt and Mac Construction. The other potential competitors that could bid on projects but do not include Ohio Valley Asphalt, Nally & Haydon Surfacing (District 4), ATS Construction (District 7), and Nally & Gibson Georgetown (District 7). There are four firms where both firms avoid bidding against each other in their respective counties. These include Commercial Pavers, H.G. Mays, Mago Construction, and Nally & Gibson Georgetown where there is evidence of tacit collusion (see Table 6.23). There is only one bid that has a single bidder. The bids average 18.29 percent below the engineer's estimate. The one single bid is only \$4,492.91 above the competitive level for District 5. Like all the counties in the district, with the exception of Franklin County, the competition has been high and the bid levels have been low.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 5 is very competitive. There is evidence of tacit collusion between firms in every county. However, in the competitive counties firms probably avoid bidding because there is so much competition, and not as part of a strategy to raise bid levels. There are a few exceptions including Trimble County and Franklin County where there is only one bidder on every project. The tacit collusion results in single-bid contracts that are \$854,582.35 above the competitive level. For a district that had around \$50 million in projects, the competition put downward pressure on bids and kept them well below the engineer's estimate and so the effect of the tacit collusion is very low on bid prices.

Table 6.20: Summary of Tacit Collusion for District 5 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Trimble				3	\$ 995,953.00	-0.59	Yes	Three Firms (A)	\$ 150,189.71
TOTAL (WITHOUT ASPHALT PLANTS)				3	\$ 995,953.00	-0.59			
WITH ASPHALT PLANTS									
Bullitt	6	\$ 1,847,832.90	-18.11				Yes	Six Firms (B)	Competitive
Franklin				9	\$ 2,956,437.61	2.20	Yes	Eleven Firms (C)	\$ 528,315.40
Henry	6	\$ 1,663,495.26	-10.31	6	\$ 1,120,728.10	0.06	Yes	Nine Firms (D)	\$ 176,357.77
Jefferson	29	\$ 22,575,346.20	-14.56	3	\$ 8,676,343.00	6.24	Yes	Five Firms (E)	Competitive
Oldham	9	\$ 2,631,209.78	-16.29				Yes	Two Firms (F)	Competitive
Shelby	7	\$ 4,413,598.50	-18.84	1	\$ 365,277.20	-14.44	Yes	Five Firms (G)	\$ 4,492.91
Spencer	4	\$ 2,062,491.25	-21.12	3	\$ 737,618.60	-12.25	Yes	Seven Firms (H)	\$ 25,226.56
TOTAL (WITH ASPHALT PLANTS)	61	\$ 35,193,973.89	-15.67	22	\$13,856,404.51	-1.06			
TOTAL (DISTRICT 5)	61	\$ 35,193,973.89	-15.67	25	\$14,852,357.51	-1.01			\$ 884,582.35

(A) These firms include Commercial Pavers, Eaton Asphalt Paving, and Ohio Valley Asphalt

(B) These firms include Commercial Pavers, Mago Construction, Nally & Haydon Surfacing, Ohio Valley Asphalt, Scotty's Contracting and Shelbyville Asphalt

(C) These firms include The Allen Company, ATS Construction, Commercial Pavers, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Lexington Quarry, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and Shelbyville Asphalt

(D) These firms include ATS Construction, Barrett Paving, Commercial Pavers, Eaton Asphalt Paving, H.G. Mays, Mago Construction, Nally & Gibson Georgetown, Ohio Valley Asphalt, and Shelbyville Asphalt

(E) These firms include Commercial Pavers, Mago Construction, Ohio Valley Asphalt, Scotty's Contracting and Shelbyville Asphalt

(F) These firms include Commercial Pavers and Ohio Valley Asphalt

(G) These firms include Commercial Pavers, H.G. Mays, Mago Construction, Nally & Gibson Georgetown, and Shelbyville Asphalt

(H) These firms include The Allen Company, Commercial Pavers, H.G. Mays, Lincoln County Ready Mix, Mago Construction, Nally & Haydon Surfacing, and Shelbyville Asphalt

Table 6.21: Summary Statistics for District 5 Firms

VARIABLES	Commercial Pavers		Flynn Brothers		HG Mays		Mago Construction		Ohio Valley Asphalt		Shelbyville Asphalt	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.262	0.441	0.188	0.392	0.102	0.303	0.179	0.384	0.143	0.351	0.0280	0.165
Distance Variables												
Distance (0 to 10 miles) [reference variable]	0.149	0.356	0.170	0.377	0.0456	0.209	0.0684	0.253	0.0606	0.239	0.00935	0.0964
Distance (11 to 20 miles)	0.114	0.318	0.0727	0.26	0.0643	0.246	0.219	0.414	0.160	0.368	0.0794	0.271
Distance (21 to 30 miles)	0.109	0.312	0.145	0.354	0.201	0.401	0.281	0.45	0.117	0.322	0.238	0.427
Distance (31 to 40 miles)	0.198	0.399	0.164	0.371	0.177	0.382	0.167	0.373	0.169	0.375	0.168	0.375
Distance (41 to 50 miles)	0.183	0.388	0.242	0.43	0.268	0.444	0.132	0.338	0.221	0.416	0.299	0.459
Distance (51 to 60 miles)	0.248	0.433	0.206	0.406	0.244	0.43	0.133	0.34	0.273	0.446	0.206	0.405
Other Control Variables												
Jobs Under Contract	2.307	1.388	0.297	0.655	2.365	1.632	6.147	2.196	1.359	1.304	0	-
Engineer's Estimate	586,650	1.01E+06	639,038	1.10E+06	552,908	1.48E+06	638,763	1.62E+06	504,737	8.76E+05	670,503	1.76E+06
Competitive Variables												
Number of Competitor Service Areas	10.29	2.877	10.18	2.92	10.13	2.84	8.968	3.021	9.788	3.121	11.40	2.428
Zero other competitive bid proposal purchased [reference variable]	0	-	0	-	0.0429	0.203	0.0544	0.227	0.0433	0.204	0	-
One other competitive bid proposal purchased	0.361	0.482	0.352	0.479	0.504	0.501	0.446	0.497	0.273	0.446	0.472	0.5
Two other competitive bid proposals purchased	0.287	0.454	0.182	0.387	0.249	0.433	0.302	0.459	0.225	0.419	0.201	0.402
Three or more other competitive bid proposals purchased	0.351	0.479	0.467	0.5	0.204	0.403	0.198	0.399	0.459	0.499	0.327	0.47
County Variables												
Project in same county-no rival	0	-	0	-	0.0536	0.226	0.128	0.334	0.0779	0.269	0.0374	0.19
Project in same county-rival	0.188	0.392	0.230	0.422	0.0107	0.103	0.0105	0.102	0	-	0	-
Project in adjacent county-no rival [reference variable]	0.168	0.375	0.109	0.313	0.223	0.416	0.277	0.448	0.195	0.397	0.0981	0.298
Project in adjacent county-rival	0.644	0.48	0.661	0.475	0.713	0.453	0.584	0.493	0.727	0.446	0.864	0.343
Observations	202		165		373		570		231		214	

Table 6.22: Regression results for District 5 Firms

VARIABLES	Commercial Pavers		Flynn Brothers		HG Mays		Mago Construction		Ohio Valley Asphalt		Shelbyville Asphalt	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.357*** (0.111)	0.133** (0.0583)	-0.179 (0.171)	-0.181 (0.182)	-0.379*** (0.107)	0.0414 (0.0710)	-0.454*** (0.0581)	-0.249*** (0.0635)	-0.468*** (0.105)	-0.00301 (0.0828)	0.295** (0.116)	0.852*** (0.131)
Distance (21 to 30 miles)	-0.345*** (0.125)	0.396** (0.156)	-0.480*** (0.117)	-0.472 (0.421)	-0.639*** (0.101)	0.000334 (0.118)	-0.727*** (0.0514)	-0.425*** (0.0716)	-0.606*** (0.110)	-0.0681 (0.117)	0.0259 (0.0362)	0.876*** (0.124)
Distance (31 to 40 miles)	-0.621*** (0.0958)	0.133 (0.135)	-0.623*** (0.100)	-0.605 (0.419)	-0.721*** (0.0969)	-0.0701 (0.113)	-0.829*** (0.0478)	-0.505*** (0.0724)	-0.693*** (0.0985)	-0.162 (0.103)	-0.00508 (0.0368)	0.852*** (0.126)
Distance (41 to 50 miles)	-0.675*** (0.0854)	0.0638 (0.123)	-0.582*** (0.104)	-0.567 (0.420)	-0.778*** (0.0948)	-0.128 (0.113)	-0.862*** (0.0479)	-0.515*** (0.0742)	-0.776*** (0.0872)	-0.271*** (0.101)	-0.0195 (0.0460)	0.850*** (0.125)
Distance (51 to 60 miles)	-0.723*** (0.0784)	0.0213 (0.119)	-0.631*** (0.0971)	-0.614 (0.417)	-0.804*** (0.0960)	-0.145 (0.115)	-0.889*** (0.0491)	-0.545*** (0.0763)	-0.811*** (0.0871)	-0.294*** (0.103)	-0.0141 (0.0458)	0.856*** (0.123)
Jobs Under Contract	-0.00423 (0.0139)	-0.0228** (0.0111)	0.0182 (0.0326)	0.0188 (0.0326)	-0.00106 (0.00686)	-0.00121 (0.00622)	0.00350 (0.00440)	0.00231 (0.00360)	0.000483 (0.0113)	0.000756 (0.0100)	0 (0)	0 (0)
Engineer's Estimate	-1.43e-08 (2.95e-08)	-1.25e-08 (2.96e-08)	-7.12e-08*** (1.63e-08)	-7.14e-08*** (1.63e-08)	-3.02e-09 (4.36e-09)	-1.98e-09 (3.41e-09)	-4.65e-10 (3.30e-09)	2.63e-09 (2.38e-09)	-2.42e-08* (1.29e-08)	-1.23e-08 (1.09e-08)	-2.53e-10 (9.39e-10)	-8.35e-10 (6.54e-10)
Potential Competitors	0.00407 (0.00767)	0.0115 (0.00766)	0.00123 (0.00866)	-0.000710 (0.00873)	-0.0223*** (0.00532)	-0.0138*** (0.00508)	-0.0188*** (0.00492)	-0.0114*** (0.00415)	-0.00961 (0.00584)	-0.00653 (0.00499)	0.00526 (0.00576)	0.00481 (0.00491)
One competitive bid proposal purchased	-0.307*** (0.0816)	-0.307*** (0.0788)			-0.348*** (0.105)	-0.238 (0.147)	-0.470*** (0.0552)	-0.189*** (0.0620)	-0.412*** (0.105)	-0.258** (0.117)	-0.0117 (0.0256)	0.0179 (0.0141)
Two competitive bid proposals purchased	-0.245*** (0.0813)	-0.221*** (0.0741)	0.149** (0.0643)	0.149** (0.0647)	-0.355*** (0.105)	-0.222 (0.150)	-0.510*** (0.0574)	-0.214*** (0.0679)	-0.455*** (0.103)	-0.315*** (0.116)		
Three or more competitive bid proposals purchased			0.113* (0.0661)	0.116* (0.0668)	-0.367*** (0.107)	-0.225 (0.148)	-0.632*** (0.0572)	-0.273*** (0.0709)	-0.601*** (0.0964)	-0.436*** (0.109)	-0.0400 (0.0462)	0.0217 (0.0307)
Project in same county-rival						0.128 (0.0996)		0.182** (0.0715)				
Project in adjacent county-no rival		-0.764*** (0.116)		-0.0619 (0.407)		-0.653*** (0.133)		-0.380*** (0.0842)		-0.520*** (0.105)		-0.831*** (0.147)
Project in adjacent county-rival		-0.754*** (0.109)		0.00133 (0.406)		-0.729*** (0.133)		-0.527*** (0.0793)		-0.638*** (0.0949)		-0.836*** (0.146)
Constant	0.924*** (0.0842)	0.890*** (0.0841)	0.591*** (0.150)	0.605*** (0.150)	1.355*** (0.0734)	1.210*** (0.0723)	1.488*** (0.0811)	1.278*** (0.0735)	1.394*** (0.114)	1.294*** (0.107)	-0.0332 (0.115)	-0.0875 (0.0973)
Observations	202	202	165	165	373	373	570	570	231	231	214	214
R-squared	0.592	0.663	0.433	0.435	0.588	0.667	0.577	0.692	0.585	0.665	0.245	0.695

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.23: Additional regression results for District 5 firms and firms outside District 5

VARIABLES	Commercial Pavers			Flynn Brothers			HG Mays			Mago Construction		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival							0.128 (0.0996)	0.252** (0.117)	0.218* (0.111)	0.182** (0.0715)	0.143* (0.0767)	0.423*** (0.0733)
Project in adjacent county-no rival	-0.764*** (0.116)	-0.737*** (0.107)		-0.0619 (0.407)	-0.115 (0.386)		-0.653*** (0.133)	-0.408*** (0.144)		-0.380*** (0.0842)	-0.296*** (0.0842)	
Project in adjacent county-rival	-0.754*** (0.109)		-0.760*** (0.112)	0.00133 (0.406)		0.00249 (0.410)	-0.729*** (0.133)		-0.374*** (0.128)	-0.527*** (0.0793)		-0.364*** (0.0605)
Project in adjacent county-Allen Company		-0.751*** (0.119)			-0.166 (0.390)			-0.406*** (0.148)			-0.314*** (0.0822)	
Project in adjacent county-ATS Construction		-0.715*** (0.119)						-0.546*** (0.155)			-0.427*** (0.0827)	
Project in adjacent county-Barrett Paving								-0.466*** (0.144)			-0.449*** (0.100)	
Project in adjacent county-Bluegrass Paving								0.458*** (0.148)			0.316*** (0.101)	
Project in adjacent county-Commercial Pavers/Flynn Brothers								-0.433*** (0.146)			-0.699*** (0.0842)	
Project in adjacent county-Eaton Asphalt Paving		-0.761*** (0.113)						-0.450*** (0.145)			-0.308*** (0.0825)	
Project in adjacent county-Glass Paving		-0.727*** (0.106)			-0.0123 (0.388)						-0.351*** (0.0814)	
Project in adjacent county-HG Mays		-0.784*** (0.113)			-0.0168 (0.390)						-0.383*** (0.0780)	
Project in adjacent county-Hinkle Contracting								-0.541*** (0.141)			-0.384*** (0.0808)	
Project in adjacent county-Lexington Quarry		-0.728*** (0.116)						-0.499*** (0.148)			-0.479*** (0.0857)	
Project in adjacent county-Lincoln County Ready Mix								0.0325 (0.0300)			-0.381*** (0.0650)	
Project in adjacent county-Mago Construction		-0.784*** (0.103)			-0.0554 (0.386)			-0.420*** (0.151)				
Project in adjacent county-Nally & Gibson Georgetown		-0.741*** (0.122)						-0.538*** (0.156)			-0.361*** (0.0849)	
Project in adjacent county-Nally & Haydon		-0.763*** (0.104)			-0.0283 (0.387)			-0.360** (0.155)			-0.448*** (0.0829)	
Project in adjacent county-Ohio Valley Asphalt		-0.839*** (0.0983)			0.0502 (0.386)			-0.450*** (0.144)			-0.475*** (0.0853)	
Project in adjacent county-Scotty's Contracting		-0.559*** (0.172)			-0.144 (0.389)						-0.412*** (0.0833)	
Project in adjacent county-Shelbyville Asphalt		-0.255 (0.156)			-0.0552 (0.404)			-0.396** (0.179)			-0.524*** (0.0943)	
Project in Trimble County			-0.715*** (0.124)			0.00036 (0.410)			-0.366*** (0.130)			-0.396*** (0.0609)
Constant	0.890*** (0.0841)	0.927*** (0.0953)	0.850*** (0.104)	0.605*** (0.150)	0.560*** (0.166)	0.598*** (0.168)	1.210*** (0.0723)	1.306*** (0.0974)	1.119*** (0.0535)	1.278*** (0.0735)	1.264*** (0.0818)	1.227*** (0.0737)
Observations	202	202	202	165	165	165	373	373	373	570	570	570
R-squared	0.663	0.716	0.665	0.435	0.445	0.436	0.667	0.665	0.764	0.692	0.710	0.773

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.23 (continued)

VARIABLES	Ohio Valley Asphalt (District 5)			Shelbyville Asphalt (District 5)			Nally & Haydon Surfacing (District 4)			Scotty's Contracting and Stone (District 4)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival										-0.181*	-0.166	-0.218*
										(0.108)	(0.112)	(0.114)
Project in adjacent county-no rival	-0.520***	-0.00685		-0.831***	-0.413***		-0.288**	-0.0603		-0.189***	-0.0616	
	(0.105)	(0.116)		(0.147)	(0.125)		(0.111)	(0.0698)		(0.0625)	(0.0731)	
Project in adjacent county-rival	-0.638***		-0.229***	-0.836***		-0.836***	-0.371***		-1***	-0.544***		-0.648***
	(0.0949)		(0.0679)	(0.146)		(0.148)	(0.110)		(0)	(0.0708)		(0.106)
Project in adjacent county-Allen Company					-0.423***			-0.0718				
					(0.124)			(0.0553)				
Project in adjacent county-ATS Construction		0.0446			-0.419***			-0.0783				
		(0.123)			(0.118)			(0.0522)				
Project in adjacent county-Barrett Paving		-0.0668			-0.409***							
		(0.120)			(0.125)							
Project in adjacent county-Bluegrass Paving		0.267										
		(0.180)										
Project in adjacent county-Commercial Pavers/Flynn Brothers		-0.522***			-0.308**			-0.0495			-0.407***	
		(0.0979)			(0.127)			(0.0615)			(0.0959)	
Project in adjacent county-Eaton Asphalt Paving		-0.392**			-0.396***							
		(0.181)			(0.133)							
Project in adjacent county-Glass Paving								-0.0967**			-0.635***	
								(0.0448)			(0.126)	
Project in adjacent county-HG Mays		-0.00697			-0.420***			-0.100*				
		(0.129)			(0.120)			(0.0525)				
Project in adjacent county-Hinkle Contracting					-0.427***			-0.102				
					(0.119)			(0.0620)				
Project in adjacent county-Lexington Quarry					-0.423***			-0.112*				
					(0.119)			(0.0580)				
Project in adjacent county-Lincoln County Ready Mix								-0.129**				
								(0.0588)				
Project in adjacent county-Mago Construction		0.0730			-0.358***			-0.163***			-0.248**	
		(0.122)			(0.118)			(0.0551)			(0.0986)	
Project in adjacent county-Nally & Gibson Georgetown		0.0525			-0.432***							
		(0.120)			(0.119)							
Project in adjacent county-Nally & Haydon		0.0619			-0.429***						-0.273***	
		(0.122)			(0.119)						(0.0964)	
Project in adjacent county-Ohio Valley Asphalt					-0.425***			-0.0525			-0.272***	
					(0.133)			(0.0581)			(0.0886)	
Project in adjacent county-Scotty's Contracting		0.0234			-0.385***			-0.0584				
		(0.120)			(0.131)			(0.0639)				
Project in adjacent county-Shelbyville Asphalt		-0.189						-0.0709			-0.215**	
		(0.124)						(0.0560)			(0.100)	
Project in Trimble County			0.145			-0.824***						
			(0.124)			(0.167)						
Constant	1.294***	1.367***	1.241***	-0.0875	-0.0782	-0.0907	1.048***	1.037***	1***	1.024***	1.065***	0.960***
	(0.107)	(0.0911)	(0.133)	(0.0973)	(0.180)	(0.109)	(0.0468)	(0.0846)	(0)	(0.0426)	(0.0506)	(0.0340)
Observations	231	231	231	214	214	214	291	291	291	339	339	339
R-squared	0.665	0.727	0.640	0.695	0.453	0.695	0.862	0.853	1.000	0.740	0.749	0.849

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.23 (continued)

VARIABLES	Barrett Paving (District 6)			Bluegrass Paving (District 6)			Eaton Asphalt Paving (District 6)			The Allen Company (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	-0.0460 (0.0377)	-0.0894** (0.0412)	0.0267 (0.0330)				-0.109* (0.0656)	-0.145** (0.0656)	-0.0173 (0.0277)	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)
Project in adjacent county-no rival	-0.276*** (0.0736)	-0.334*** (0.0727)		-0.0974 (0.134)	-0.0758 (0.139)		-0.300*** (0.0877)	-0.431*** (0.0902)		-0.177*** (0.0637)	-0.142** (0.0576)	
Project in adjacent county-rival	-0.380*** (0.104)		-0.863*** (0.0782)	-0.173 (0.146)		-0.248 (0.202)	-0.310*** (0.0878)		-0.346*** (0.0880)	-0.424*** (0.0671)		-1*** (0)
Project in adjacent county-Allen Company												
Project in adjacent county-ATS Construction		-0.352*** (0.0790)					-0.462*** (0.0806)			-0.678*** (0.0720)		
Project in adjacent county-Barrett Paving					-0.216 (0.176)		-0.0267 (0.0675)			-0.251*** (0.0778)		
Project in adjacent county-Bluegrass Paving												
Project in adjacent county-Commercial Pavers/Flynn Brothers												
Project in adjacent county-Eaton Asphalt Paving		-0.193 (0.246)			-0.328 (0.207)							
Project in adjacent county-Glass Paving												
Project in adjacent county-HG Mays		-0.289** (0.116)			0.0848 (0.173)		-0.533*** (0.116)			-0.244*** (0.0645)		
Project in adjacent county-Hinkle Contracting		-0.401*** (0.0788)					-0.650*** (0.111)			-0.385*** (0.0683)		
Project in adjacent county-Lexington Quarry										-0.445*** (0.0693)		
Project in adjacent county-Lincoln County Ready Mix												
Project in adjacent county-Mago Construction		-0.550*** (0.101)			-0.146 (0.144)		-0.405*** (0.119)			-0.331*** (0.0765)		
Project in adjacent county-Nally & Gibson Georgetown		-0.364*** (0.0819)			-0.0972 (0.155)		-0.412*** (0.0782)			-0.247*** (0.0651)		
Project in adjacent county-Nally & Haydon										-0.307*** (0.0640)		
Project in adjacent county-Ohio Valley Asphalt		-0.520*** (0.0979)			-0.0726 (0.146)		-0.737*** (0.113)					
Project in adjacent county-Scotty's Contracting												
Project in adjacent county-Shelbyville Asphalt		-0.305*** (0.101)					-0.482*** (0.0981)			-0.227*** (0.0787)		
Project in Trimble County			-0.905*** (0.0732)			-0.242 (0.219)			-0.396*** (0.0933)			
Constant	1.179*** (0.0644)	1.317*** (0.101)	1.023*** (0.0476)	0.640*** (0.166)	0.635*** (0.177)	0.583*** (0.143)	1.180*** (0.108)	1.309*** (0.120)	1.096*** (0.0972)	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)
Observations	182	182	182	135	135	135	244	244	244	336	336	336
R-squared	0.841	0.863	0.900	0.547	0.555	0.553	0.572	0.666	0.642	0.788	0.834	1.000

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.23 (continued)

VARIABLES	ATS Construction (District 7)			Hinkle Contracting (District 7)			Lexington Quarry (District 7)			Lincoln County Ready Mix (District 7)			Nally & Gibson Georgetown (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival															
Project in adjacent county-no rival	-0.300 (0.198)	-0.290 (0.204)		-0.277*** (0.0693)	-0.244*** (0.0650)		-0.177 (0.195)	0.0911 (0.259)		-0.330* (0.183)	-0.341* (0.185)		-1*** (0)	0* (0)	
Project in adjacent county-rival	-0.314 (0.196)		-0.332* (0.198)	-0.356*** (0.0769)		-0.683*** (0.111)	-0.254 (0.192)		-0.283 (0.195)	-0.540*** (0.187)	-0.739*** (0.224)		-1*** (0)		0*** (0)
Project in adjacent county-Allen Company		-0.311 (0.201)			-0.341*** (0.0759)			0.0637 (0.259)			-0.284 (0.226)			0* (0)	
Project in adjacent county-ATS Construction					-0.391*** (0.0843)			-0.278 (0.198)			-0.503*** (0.190)			0** (0)	
Project in adjacent county-Barrett Paving		-0.287 (0.203)			-0.262*** (0.0667)			0.0483 (0.260)						0* (0)	
Project in adjacent county-Bluegrass Paving		-0.0129 (0.00795)			0.0248 (0.0657)									-0 (0)	
Project in adjacent county-Commercial Pavers/Flynn Brothers															
Project in adjacent county-Eaton Asphalt Paving					-0.0134 (0.0633)										
Project in adjacent county-Glass Paving															
Project in adjacent county-HG Mays		-0.308 (0.201)			-0.318*** (0.0726)			0.00508 (0.265)			-0.387* (0.200)			0* (0)	
Project in adjacent county-Hinkle Contracting		-0.299 (0.203)						0.0761 (0.259)			-0.570*** (0.190)			0* (0)	
Project in adjacent county-Lexington Quarry		-0.339* (0.201)			-0.328*** (0.0749)						-0.809*** (0.204)			0* (0)	
Project in adjacent county-Lincoln County Ready Mix		0.0143 (0.0153)			0.0488* (0.0251)			-0.0451 (0.0456)						0*** (0)	
Project in adjacent county-Mago Construction		-0.306 (0.202)			-0.300*** (0.0706)			0.0270 (0.261)			-0.540*** (0.194)			0* (0)	
Project in adjacent county-Nally & Gibson Georgetown		-0.331* (0.200)			-0.354*** (0.0791)			0.00107 (0.267)			-0.398** (0.195)				
Project in adjacent county-Nally & Haydon		-0.321 (0.200)			-0.282*** (0.0697)			0.0317 (0.264)			-0.652*** (0.197)			0* (0)	
Project in adjacent county-Ohio Valley Asphalt		-0.299 (0.202)												0* (0)	
Project in adjacent county-Scotty's Contracting															
Project in adjacent county-Shelbyville Asphalt		-0.301 (0.204)			-0.236*** (0.0679)			0.0370 (0.264)			-0.442** (0.194)			0* (0)	
Project in Trimble County															
Constant	0.983*** (0.0286)	0.955*** (0.0549)	1.005*** (0.0150)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	0.975*** (0.107)	0.936*** (0.163)	1.133*** (0.0930)	0.947*** (0.190)	1.042*** (0.228)	0.859*** (0.190)	1*** (0)	1*** (0)	1*** (0)
Observations	283	283	283	531	531	531	239	239	239	229	229	229	270	270	270
R-squared	0.883	0.884	0.888	0.892	0.893	0.942	0.702	0.739	0.852	0.473	0.538	0.668	1.000	1.000	1.000

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.20: District 5

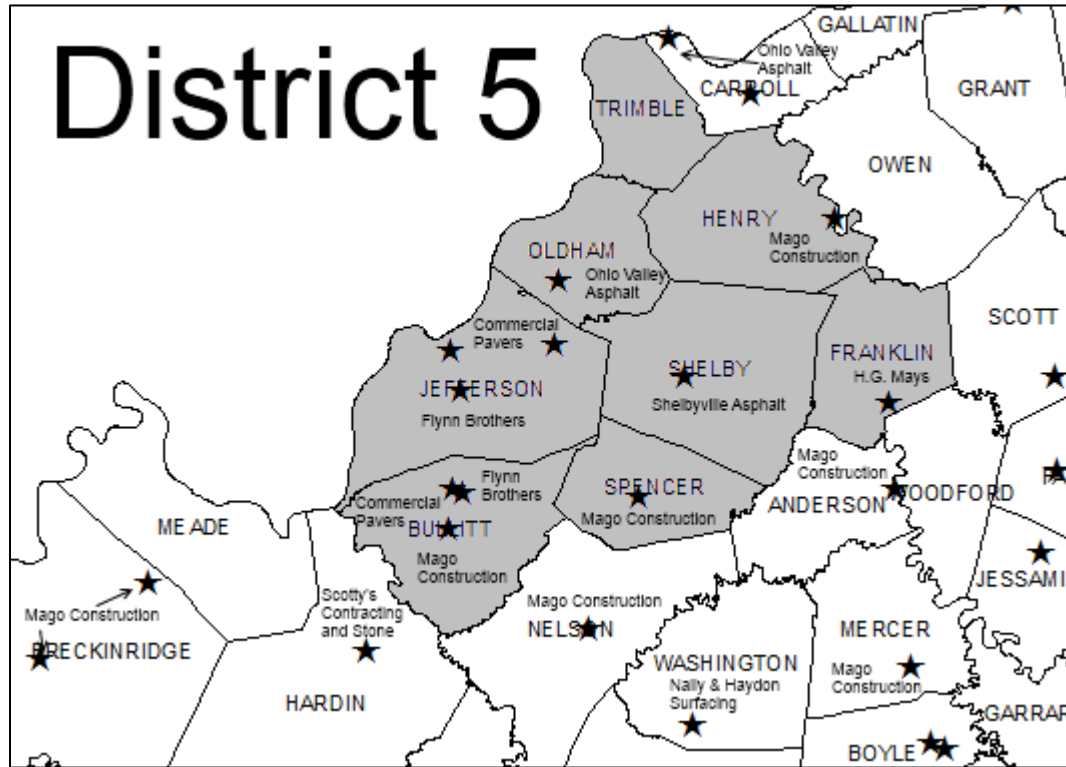


Figure 6.21: Commercial Pavers Service Area

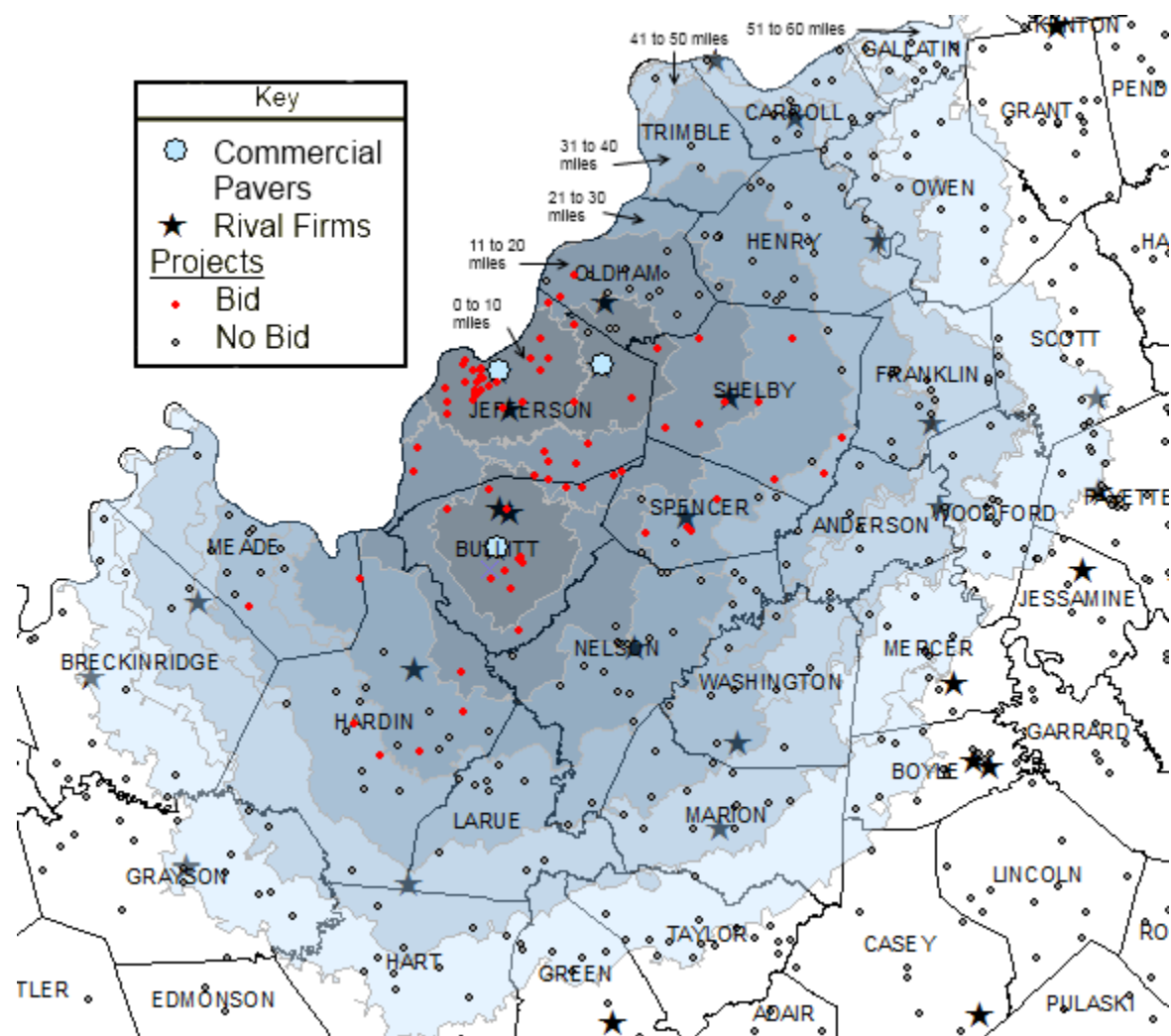
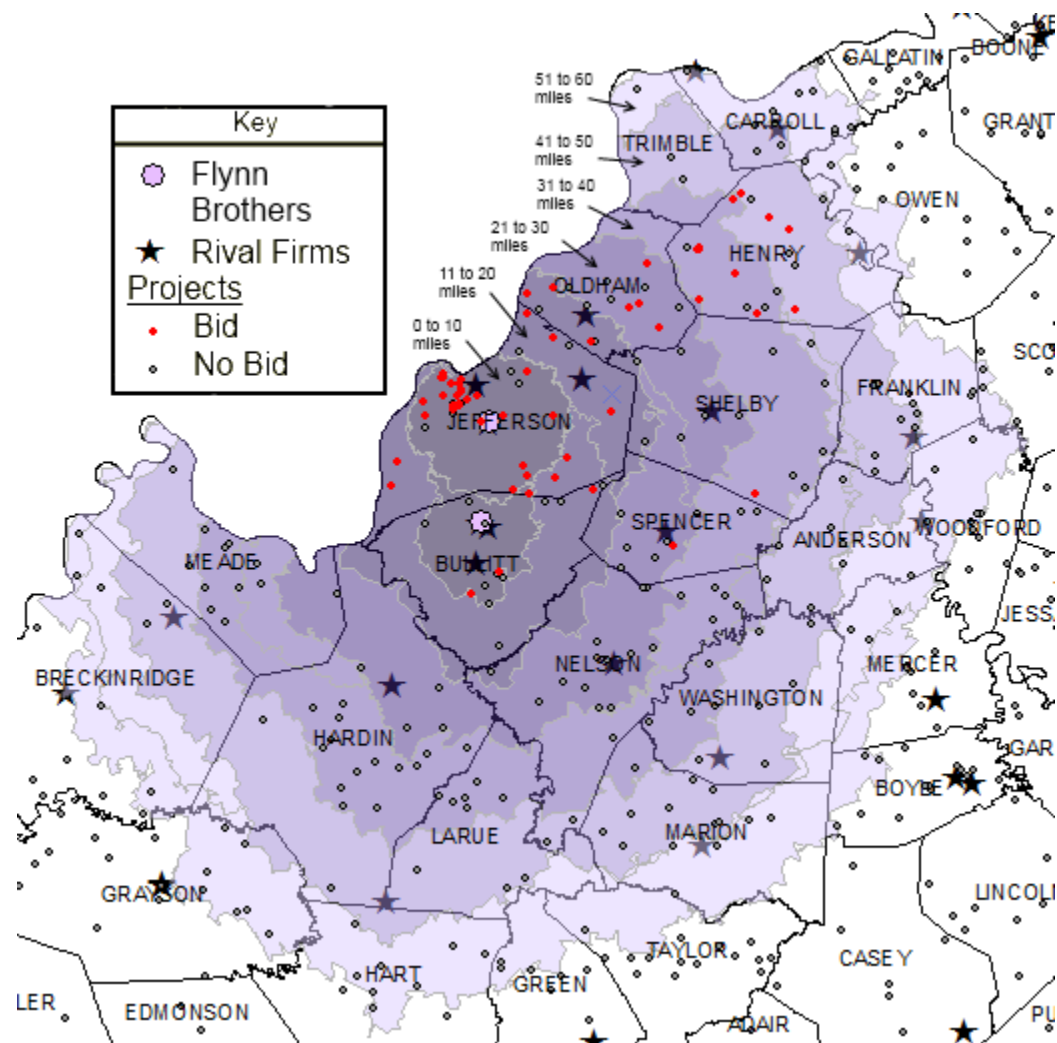


Figure 6.22: Flynn Brothers Service Area



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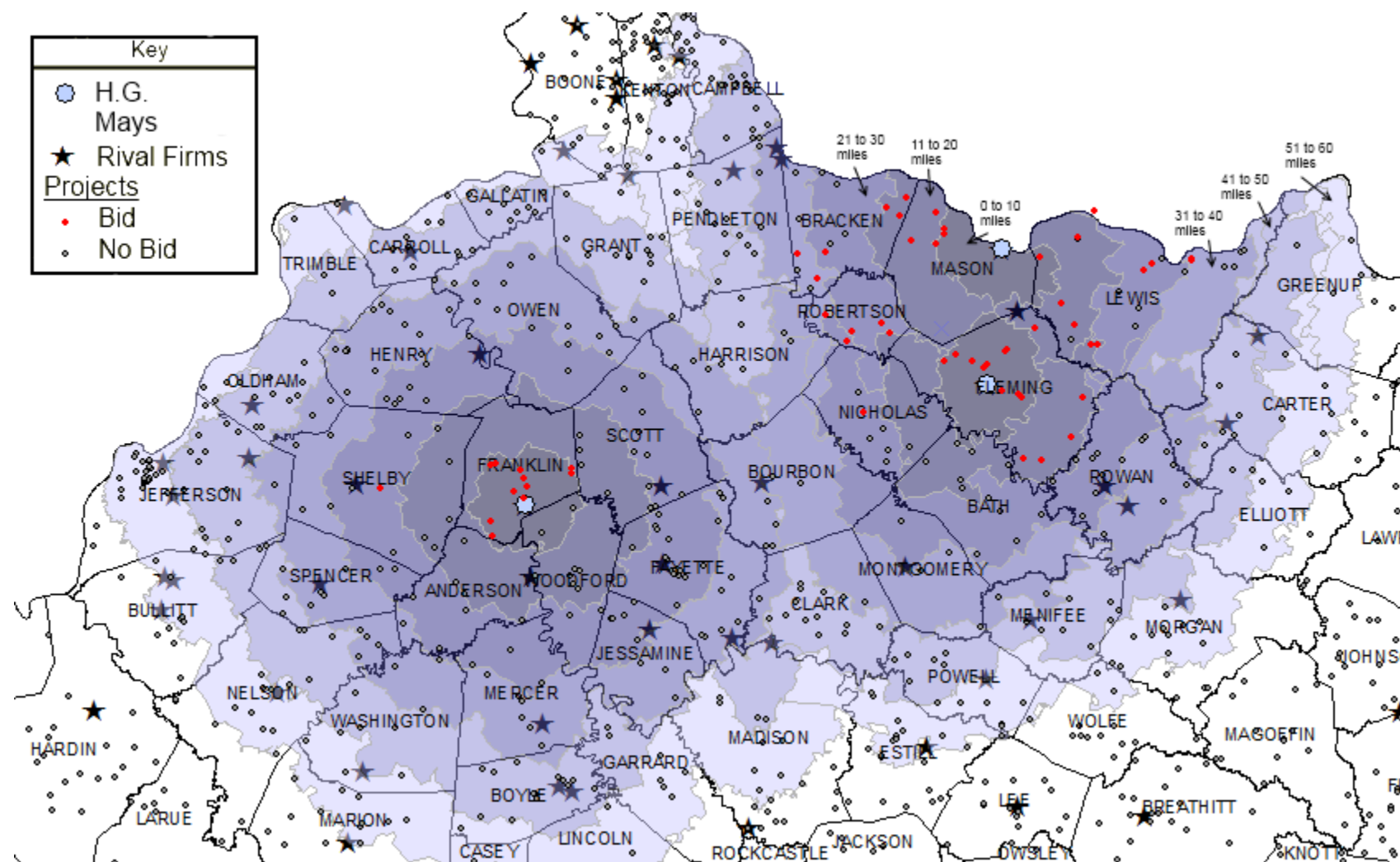


Figure 6.24: Mago Construction Service Area

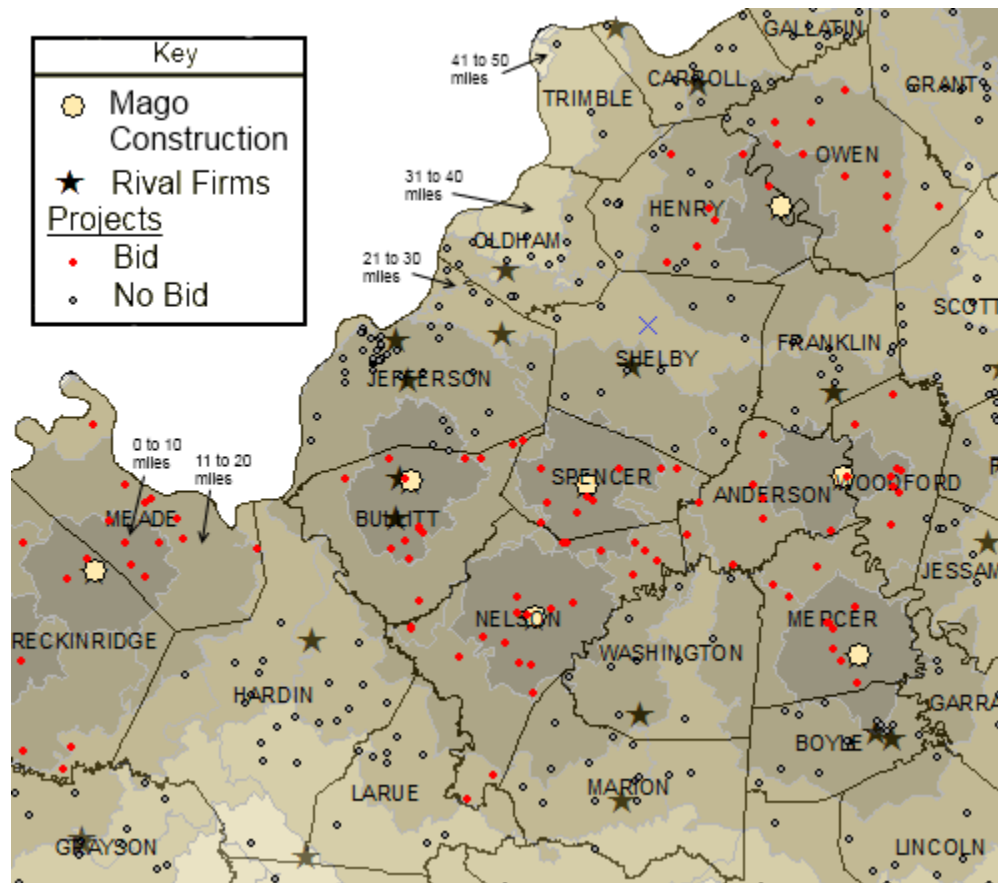


Figure 6.25: Ohio Valley Asphalt Service Area

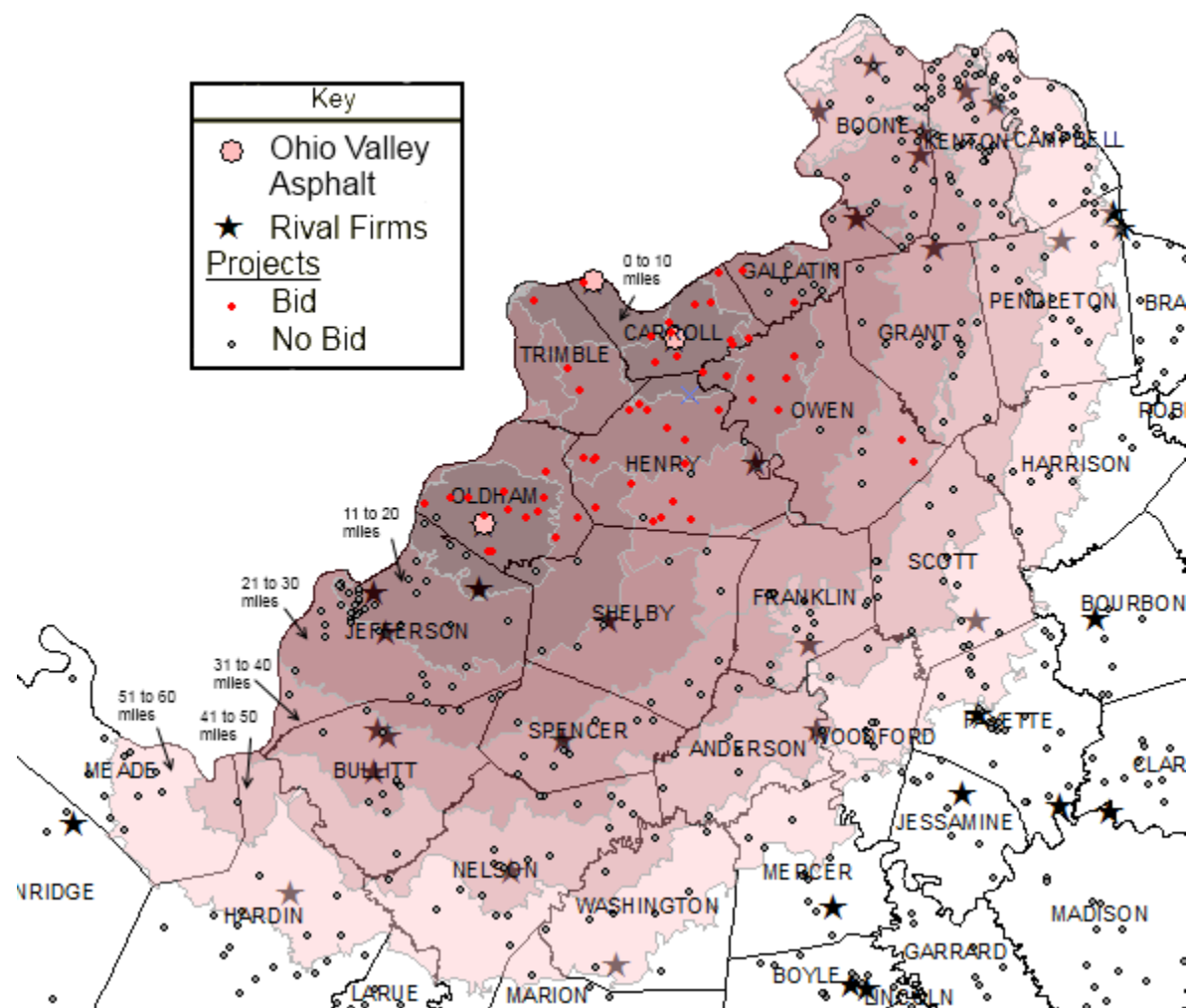
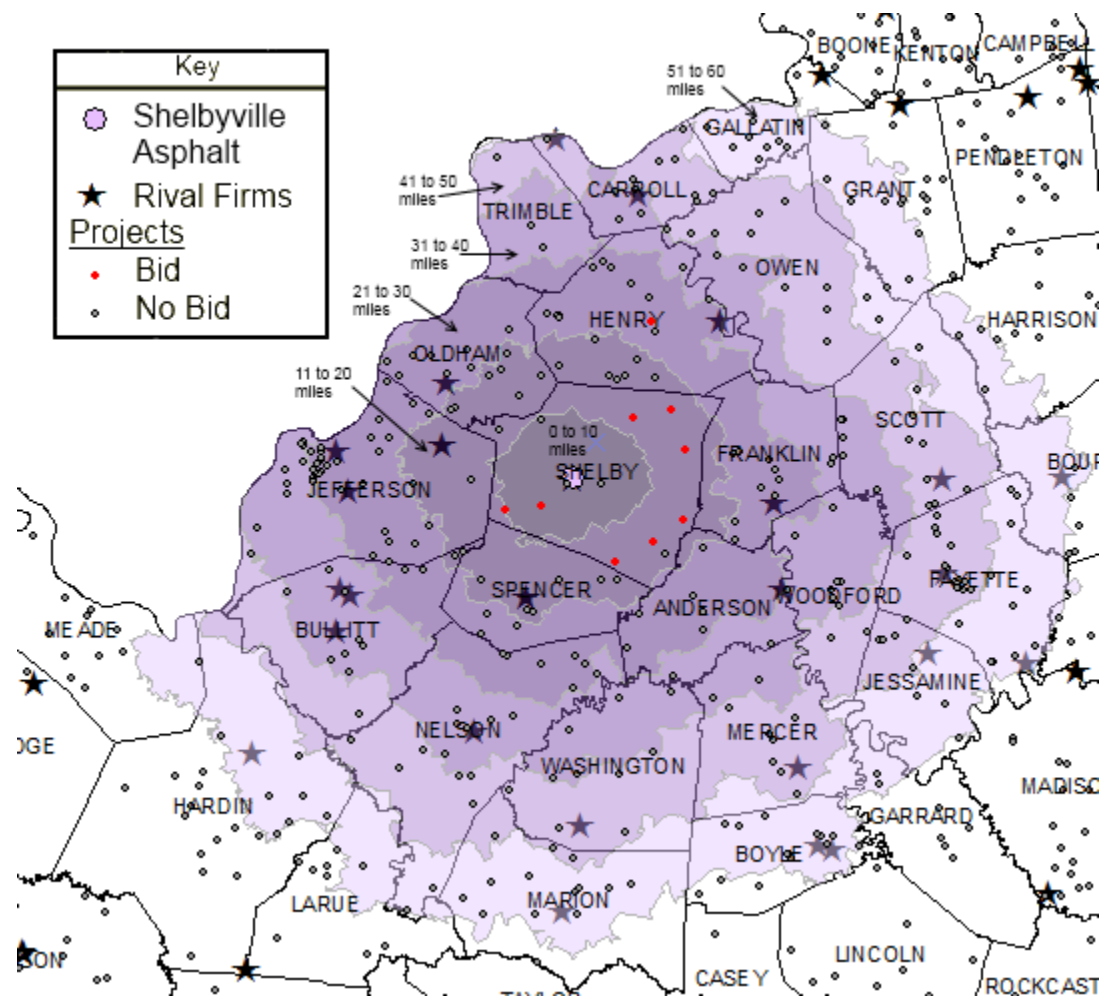


Figure 6.26: Shelbyville Asphalt Service Area



6.7 District 6 – Northern Kentucky

District 6 consists of firms in the Northern Kentucky area across the river from Cincinnati, Ohio. There are five firms that have plants located in this district and that compete on projects: Barrett Paving, Bluegrass Paving, Eaton Asphalt Paving, Mago Construction, and Ohio Valley Asphalt. There are also H.G. Mays and Hinkle Contracting that bid on projects in this district. There is evidence of tacit collusion in all of the counties. However, in Boone, Campbell, Grant and Kenton Counties the impact of this tacit collusion is negligible on bid levels. Firms establish collusive agreements about which counties they should or should not bid in. This carries into all counties where that rival firm has a plant or bids. This is the case in District 5. So there are competitive counties that have firms who are tacitly colluding with other firms who do not bid on projects in those counties. As discussed in District 5, this lack of bidding by some firms could also result from the fierce competition in the county. Firms realize they probably will not win the project, so they refuse to bid. There are some counties such as Harrison County where the tacit collusion results in higher bid levels. The result of this tacit collusion is that single-bid contracts are \$845,722.12 above the competitive level for District 6.

Projects in Northern Kentucky average 11.86 percent below the engineer's estimate, which is well below the Kentucky average of 3.84 percent below the engineer's estimate. An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.24, Table 6.25, Table 6.26, and Table 6.27. A map for the firms follows the tables. The additional regression results found in Table 6.27 includes all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.7.1 Firms with Asphalt Plants in District 6

BARRETT PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Barrett Paving has three asphalt plants located in District 6. Their primary competitors in this district are Bluegrass Paving, Eaton Asphalt Paving, and Mago Construction. They bid on 63 projects in Kentucky and all of them are in District 6. They were awarded 16 of the 65 projects. The contracted value of the 63 projects was \$17,286,847.43. The average number of bidders on

these projects was 2.57 bidders. There are no single-bid contracts on any of these projects. The 63 projects average 16.05 percent below the engineer's estimate. Like the Louisville area of District 5, the Northern Kentucky area near Cincinnati is a very competitive and this competition puts downward pressure on bids.

FIRM BID FUNCTION

The bid function for Barrett Paving is in Table 6.26. Without (A) and with the county variables (B), it indicates that once a project gets beyond 20 miles, the probability of Barrett Paving bidding on a project diminishes significantly. This is one of the major variables that are driving whether or not Barrett Paving bids on a project. The potential competitor variable indicates that they are less likely to bid on projects when there are more potential competitors. When the county variables are added, the variables for projects in the counties adjacent to where Barrett Paving has an asphalt plant are negative and significant. This is an indication that they are less likely to bid on a project in a county where they do not have an asphalt plant. The "Project in adjacent county-rival" is negative and significant and the magnitude is greater than when there is no rival firm. They are also less likely to bid on projects in counties where they have asphalt plants and so do their rivals, including Boone County. When specific firms are added in Table 6.27, they are less likely to bid on projects where ATS Construction, H.G. Mays, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and Ohio Valley Asphalt have plants. They also avoid bidding in Harrison, Owen, and Robertson County when the other factors including distance are controlled. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the "Counties" section.

BLUEGRASS PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Bluegrass Paving has one plant located in Boone County in District 6. Their primary competitors in this district are Barrett Paving, Eaton Asphalt Paving, and Mago Construction. Bluegrass Paving bid on 31 projects in Kentucky and all of them are in District 6 counties. They were awarded eight of the 31 projects. The contracted value of all of the 31 projects was \$8,984,712.01. The average number of bidders on these projects was 3.00 bidders. There were no single-bid contracts on any of these projects. The 31 projects average 15.50 percent below the engineer's estimate.

FIRM BID FUNCTION

The bid function for Bluegrass Paving is in Table 6.26. Without (A) and with the county variables (B), it indicates that once a project gets beyond 11 miles, the probability of Bluegrass Paving bidding on a project diminishes significantly. Though they do not have, on average, many jobs under contract, the more jobs they do have under contract diminishes the probability of them bidding on a project. Also if three or more competitors purchase bid proposals for a project it increases the probability of them bidding compared to if only one firm purchases a bid proposal. The county variables are not significant and indicate that the county placement of the project does not impact whether they bid on the project. When the additional firm variables are added into the regression in Table 6.27, none of the variables are significant. One of the major factors influences why they bid on a project is distance. More of their bidding behavior will be explored in the “Counties” section.

EATON ASPHALT PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Eaton Asphalt Paving has four of their five plants located in District 6. Their other plant is located in District 9. Their primary competitors in this district are Barrett Paving, Bluegrass Paving, Mago Construction, and Ohio Valley Asphalt. They bid on 99 projects in Kentucky and 85 of those are in counties in District 6. The rest of the projects are in District 9. They were awarded contracts on 39 of the 85 projects. The contracted value of the 85 projects was \$22,555,378.66. The average number of bidders on these projects was 2.42 bidders. Only three out of the 88 projects had one bidder, Eaton Asphalt Paving, and the contracted value of these projects was \$563,354, and the single-bid contracts averaged 11.20 percent below the engineer’s estimate. The contracted value of the other 82 projects averaged 15.88 percent below the engineer’s estimate.

FIRM BID FUNCTION

The bid function for Eaton Asphalt Paving is in Table 6.26. Without (A) and with the county variables (B), it indicates that once a project gets beyond 20 miles, the probability of Eaton Asphalt Paving bidding on a project diminishes significantly. They also are less likely to bid on a project if one or three or more competitors purchase a bid proposals compared to a circumstance where no firms purchase a bid proposal; however, this does not hold up when the county variables are added. The county variables are negative and significant, indicating they are

less likely to bid on projects outside the counties where they have their asphalt plants. When specific firms are added in Table 6.27, they are significant and negative for ATS Construction, H.G. Mays, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, Ohio Valley Asphalt, and The Walker Company. They are also less likely to bid on projects in Harrison and Robertson Counties when distance and the other factors are controlled. One of the major factors influences why they bid on a project is distance. More of their bidding behavior will be explored in the “Counties” section and in the District 9 section.

MAGO CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mago Construction has three of their 12 plants located in District 6. Their primary competitors in District 6 who have asphalt plants in these counties are Barrett Paving, Bluegrass Paving, Eaton Asphalt Paving, H.G. Mays, and Ohio Valley Asphalt. They bid on 102 projects in Kentucky and 27 of those are in counties in District 6. Of those 27 bids, they were awarded 25 of the contracts. The contracted value of all of the 27 projects was \$7,808,204.24. The average number of bidders on these projects was 2.00 bidders. Eight of the 27 bids only had one bidder, Mago Construction. The contracted value of these projects was \$3,120,855.73, and the projects are located in Bracken, Pendleton and Owen Counties. The contracted value of these eight single-bid contracts averaged 0.98 percent below the engineer’s estimate. For the other 19 projects with more than one bidder, the contracted value of the projects averages 15.14 percent below the engineer’s estimate. Whether or not Mago Construction is tacitly colluding will be analyzed in the “Counties” section.

FIRM BID FUNCTION

The results of the bid function for Mago Construction were discussed in detail in the District 4 section. The important points of the bid function will be highlighted here. The county variables indicate that Mago Construction is less likely to bid on a project in a county that is adjacent to the counties where they have an asphalt plant. When specific firms and counties are added in Table 6.27, all of the coefficients on the firm variables are negative and significant meaning they are less likely to bid in these counties compared to the counties where they have their asphalt plants. They are more likely to bid on projects in Owen County and less likely to bid on projects in Harrison County than on projects in the counties where they have asphalt plants. Distance, competitor behavior, and which county a project is located in all significantly influence

whether or not Mago Construction bids on a project. More of their bidding behavior will be explored in the “Counties” section.

OHIO VALLEY ASPHALT

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Ohio Valley Asphalt has two of their three asphalt plants located in District 6 in Carroll County. Their primary competitors located in District 6 are Barrett Paving, Eaton Asphalt Paving, and Mago Construction. Ohio Valley Asphalt bid on 33 projects in Kentucky, and 13 of those projects are in District 6. The contracted value of the 13 projects was \$3,099,971.04. The average number of bidders on these projects was 1.62 bidders. Only eight of the 13 bids had one bidder. The contracted value of these eight single-bid contracts averaged 2.96 percent above the engineer’s estimate. For the five projects with two or more bidders, the contracted value of the projects was 11.17 percent below the engineer’s estimate.

FIRM BID FUNCTION

The results of the bid function for Ohio Valley Asphalt were discussed in detail in the District 5 section. The important points of the bid function will be highlighted here. Distance and competitor factors influence whether they bid on a project. The county variables significantly impacted whether or not they bid on a project. They are less likely to bid on a project in an adjacent county to the counties where they have an asphalt plant. When specific firms are added they are more likely to bid in Boone County where Bluegrass Paving has an asphalt plant and less likely to bid in Gallatin County where Eaton Asphalt Paving has an asphalt plant. Also they are less likely to bid on projects in Harrison County holding all else constant. More of their bidding behavior will be explored in the “Counties” section.

6.7.2 Counties in District 6

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.27). The additional regressions for firms outside District 6 will be discussed and are found in Table 6.27. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.26). However, these variables were not displayed due to lack of space. In each county, the number

and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

HARRISON COUNTY

There are a total of seven projects in Harrison County and only one bidder, Hinkle Contracting. The total contracted value of these projects is \$2,581,285.95 which averages 3.73 percent above the engineer's estimate. The average for competitive bids for District 6 projects is 15.83 percent below the engineer's estimate (see Table 6.24). Beside Hinkle Contracting, the other potential bidders include Barrett Paving, Bluegrass Paving, Eaton Asphalt Paving, Mago Construction, The Allen Company (District 7), ATS Construction (District 7), Lexington Quarry (District 7), Nally & Gibson Georgetown (District 7), and The Walker Company (District 7). All of these firms have all of the projects in Harrison County within their 60 mile service area. In the additional regressions, the "Harrison County" variable is added; Hinkle Contracting treats Harrison County as a county where they have an asphalt plant. Firms that avoid bidding in Harrison County include Barrett Paving, Mago Construction, The Allen Company, ATS Construction, Nally & Gibson Georgetown, and The Walker Company. In turn Hinkle Contracting avoids bidding on projects in these firm's counties. While it does not indicate it in their regression, Lexington Quarry avoids bidding in Harrison County where Hinkle Contracting has an asphalt plant (see discussion in section 6.8 and see Figure 6.37). The Hinkle Contracting bid functions are in District 7. This coordination of bid results in bid levels that are \$504,899.53 above the competitive level for District 6.

OWEN COUNTY

There are a total of seven projects in Owen County. The total contracted value of these projects is \$2,397,086.00 which averages 11.14 percent below the engineer's estimate. The competitive average for District 6 projects is 15.83 percent below the engineer's estimate (see Table 6.24). There are three firms that bid regularly on projects in Owen County: Eaton Asphalt Paving, Mago Construction and Ohio Valley Asphalt. Ohio Valley Asphalt has plants in Carroll County while Mago Construction has a plant located in Henry County and Eaton Asphalt Paving has one in Gallatin County. Other potential competitors include Barrett Paving, Bluegrass Paving, Commercial Pavers (District 5), H.G. Mays (District 5), ATS Construction (District 7), and Nally &

Gibson Georgetown (District 7). The additional regressions have a variable for Owen County, and Barrett Paving, Commercial Pavers, H.G. Mays, and Nally & Gibson Georgetown are less likely to bid on projects in Owen County. Since it is pretty competitive there are not very many compelling reasons tacit collusion exists. However, there are firms that refuse to bid against each other. It has been well documented in District 5 that there is evidence of tacit collusion between Commercial Pavers and Mago Construction. There is also evidence of tacit collusion between H.G. Mays, Nally & Gibson Georgetown and Mago Construction (see Table 6.27).

Table 6.27 shows that Barrett Paving is less likely to bid on projects in counties where Mago Construction has an asphalt plant and the favor is returned by Mago Construction. Figure 6.28 and Figure 6.31 illustrate this point. Commercial Pavers and Ohio Valley Asphalt also have a tacit agreement and it extends into Owen County. Eaton Asphalt Paving is also less likely to bid on projects in Franklin and Scott Counties where H.G. Mays and Nally & Gibson Georgetown have their asphalt plants, respectively. ATS Construction does not bid in Owen County (see Figure 6.35). Like the counties in District 5, there is evidence of tacit collusion; however, the impact is very low since there is a great deal of competition among the firms that bid on projects in Owen County. There is only one project that had one bidder and Mago Construction was the lone bidder. If the other firms that tacitly collude with Mago Construction bid on the project it would have put downward pressure on the bid. This bid is \$117,817.86 above the competitive level for District 6.

ROBERTSON COUNTY

There are a total of five projects in Robertson County. The total contracted value of these projects is \$739,000.98 which averages 16.85 percent below the engineer's estimate. The average for all of District 6 projects is 11.95 percent below the engineer's estimate (see Table 6.24). A total of three firms bid on and win projects in Robertson County including H.G. Mays (District 9), Hinkle Contracting (District 7), and Mago Construction. Eaton Asphalt Paving also bid on projects but was not awarded any contracts. There was only one single-bid contract. The other potential competitors include Barrett Paving, Bluegrass Paving, The Allen Company, ATS Construction, Nally & Gibson Georgetown, and The Walker Company. The following firms are less likely to bid on projects in Robertson County: The Allen Company, Barrett Paving, Nally & Gibson Georgetown and The Walker Company. In turn Mago Construction, H.G. Mays, and Hinkle Contracting avoid bidding on projects where these firms have asphalt plants. Eaton

Asphalt Paving only avoids bidding against Nally & Gibson Georgetown and The Walker Company. While there is evidence of tacit collusion between the potential competitors for Robertson County and those that actually bid, the bidding on the projects is very competitive. On the one project with the lone bidder, H.G. Mays is the only bidder and it is 5.53 percent below the engineer's estimate. The Allen Company, Barrett Paving, Nally & Gibson Georgetown, and The Walker Company could have all bid on the project. Robertson County is on the fringe of ATS Constructions service area. It is not likely they would bid on projects anyways (see Figure 6.35). However, this tacit collusion increases bid levels above the competitive level by only \$27,104.41.

COUNTIES WITH ASPHALT PLANTS

BOONE, KENTON, AND CAMPBELL COUNTIES

There are a total of 51 projects in the Northern Kentucky counties of Boone, Kenton and Campbell Counties. These counties are across the Ohio River from Cincinnati, Ohio. The total contracted value of these projects is \$13,716,018.21 which averages 16.36 percent below the engineer's estimate. The competitive average for all of District 6 projects is 15.83 percent below the engineer's estimate (see Table 6.24). There are four major asphalt paving firms that bid on projects in these counties: Barrett Paving, Bluegrass Paving, Eaton Asphalt Paving, and Mago Construction. Each county will be analyzed individually in the next three paragraphs.

In Boone County, there are 17 projects and an average of 2.71 bidders per project. Barrett Paving, Bluegrass Paving, and Eaton Asphalt Paving all have asphalt plants in Boone County and bid on most projects. The projects average 16.27 percent below the engineer's estimate. The other potential competitors include Mago Construction and Ohio Valley Asphalt. These firms do not bid on projects in Boone County but they could. There are no single-bid projects; however, there is evidence of tacit collusion between Barrett Paving and Mago Construction, Eaton Asphalt Paving and Mago Construction, and between Eaton Asphalt Paving and Ohio Valley Asphalt (see Table 6.27). These firms are less likely to bid in each other's counties. While there is evidence of tacit collusion among firms that bid and could potentially bid on projects in Boone County, the impact of the tacit collusion is negligible. The competition puts downward pressure on the bids.

In Kenton County, there are 19 projects and average 2.63 bidders per project. Barrett Paving, Bluegrass Paving, and Eaton Asphalt Paving all bid and win projects in Kenton County. The projects average 15.35 percent below the engineer's estimate. Like Boone County, the same firms avoid bidding in Kenton County and the favor is returned by Eaton Asphalt Paving who has a plant in Kenton County. However, the impact is negligible. The one single-bid contract averages 26.33 percent below the engineer's estimate and Eaton Asphalt Paving is the lone bidder on that project.

In Campbell County, there are 15 projects and an average of 2.47 bidders per project. Barrett Paving has an asphalt plant in Campbell County. Barrett Paving, Bluegrass Paving, Eaton Asphalt Paving, and Mago Construction all bid on projects in Campbell County. The projects average 17.75 percent below the engineer's estimate. Ohio Valley Asphalt cannot bid on all the projects in Campbell County and so they are not a potential competitor. H.G. Mays is the only other potential competitor. There is evidence of tacit collusion between H.G. Mays and Barrett Paving (see Table 6.27). These firms avoid bidding in each other's counties. However, it is so competitive that this tacit collusion has no impact on bids in Campbell County. It is a very competitive area there is no evidence of tacit collusion.

While I found some evidence that firms avoid bidding against each other in these three counties, this is probably due to the fact that competition is so fierce. Mago Construction and Ohio Valley Asphalt probably do not bid because they know their costs are higher and they do not have a very good chance of winning the bid. It is very important to understand the fact that "evidence" of tacit collusion was discovered does not mean it had anticompetitive effects. In the case of these three counties, the bid levels were at the competitive level. It is also important to remember that this refusal to bid against each other could be part of a larger strategy between firms, and evidence of this strategy shows up in these competitive counties.

CARROLL COUNTY

There are a total of nine projects in Carroll County. The total contracted value of these projects is \$1,918,657.90. The project's contracted value averages 1.17 percent above the engineer's estimate. The competitive average for all of District 6 projects is 15.83 percent below the engineer's estimate (see Table 6.24). There are only two firms that bid on projects in Carroll County: Eaton Asphalt Paving and Ohio Valley Asphalt. Eaton Asphalt Paving only bid on one

project, and this project was 13.20 below the engineer's estimate. The rest of the projects were only bid on by Ohio Valley Asphalt and average 2.96 percent above the engineer's estimate.

The potential competitors for Carroll County besides the two that bid include Barrett Paving, Bluegrass Paving, Mago Construction, Commercial Pavers (District 5), Flynn Brothers (District 5), and H.G. Mays (District 5). As has been documented in District 5 and earlier in this section, Ohio Valley Asphalt and Eaton Asphalt Paving avoid bidding in each other's counties holding all else constant. While Eaton Asphalt Paving did bid on one project in Carroll County, there is evidence that they tacitly collude with each other. Figure 6.30 and Figure 6.32 show that these firms could have reasonably bid in each other's counties, but they chose not to bid. Commercial Pavers also is tacitly colluding with Ohio Valley Asphalt (see District 5). This coordination of bid results in bid levels that are \$320,274.59 above the competitive level.

GALLATIN COUNTY

In Gallatin County, Eaton Asphalt Paving has an asphalt plant. There are six projects in this county. The contracted value of these projects is \$1,163,843.21. The contracted value of the two single-bid projects averages 3.64 percent below the engineer's estimate. The average of the four multi-bid projects is 12.14 percent below the engineer's estimate (see Table 6.24). The major asphalt paving firms that bid on projects in Gallatin County are Barrett Paving and Eaton Asphalt Paving. Other potential competitors include Bluegrass Paving, Mago Construction, Ohio Valley Asphalt, H.G. Mays (District 5) and Nally & Gibson Georgetown (District 7). There is tacit collusion between Ohio Valley Asphalt and Eaton Asphalt Paving as documented in the Carroll County section. There is also evidence of tacit collusion between Eaton Asphalt Paving and Mago Construction, H.G. Mays, and Nally & Gibson Georgetown (see Table 6.27). If these firms bid on the single-bid contracts it would put downward pressure on the bids. This coordination of bid results in bid levels that are \$37,277.51 above the competitive level.

GRANT COUNTY

In Grant County, Barrett Paving has an asphalt plant. There are nine projects in this county. The contracted value of these projects is \$2,970,340.01. The major asphalt paving firms that bid on projects in Grant County are Barrett Paving, Bluegrass Paving and Eaton Asphalt Paving. There are no single-bid contracts and these ten projects average 17.15 percent below the engineer's estimate. The competitive average for District 6 projects is 15.83 percent below

the engineer's estimate (see Table 6.24). As is the case with Boone, Kenton, and Campbell Counties, there is a lot of competition for projects. There are also other firms that are potential bidders on projects in Grant County including Mago Construction, Ohio Valley Asphalt, H.G. Mays (District 5), ATS Construction (District 7), Hinkle Contracting (District 7), and Nally & Gibson Georgetown (District 7). Of these firms there is evidence of tacit collusion between Barrett Paving and ATS Construction, H.G. Mays, Hinkle Contracting, Mago Construction, and Nally & Gibson Georgetown (see Table 6.27). However, the bidding is so competitive that there are no single-bid contracts and a negligible impact on actual bids. Two things could be occurring. Firms could avoid bidding in Grant County because it is so competitive because they know they will lose money if they win the project. Also, firms could be maintaining their collusive agreements across all counties and even in competitive counties.

PENDLETON AND BRACKEN COUNTIES

Mago Construction has asphalt plants in Pendleton and Bracken Counties. There are a total of 18 projects in Bracken and Pendleton Counties and these projects average 8.77 percent below the engineer's estimate. The average number of bidders on a project is 1.61. There is not as much competition in these counties as there is in Grant or the Campbell Counties. Each county will be looked at separately to see if tacit collusion is occurring.

Bracken County is located on the eastern edge of District 6. There are three firms that bid on the nine projects in Bracken County: Eaton Asphalt Paving, H.G. Mays and Mago Construction. The contracted value of these projects is \$2,392,657.03. There are three single-bid contracts and these three projects average 4.08 percent below the engineer's estimate. The other six multi-bid projects average 15.28 percent below the engineer's estimate (see Table 6.24). Other potential competitors include Barrett Paving, Bluegrass Paving, and Hinkle Contracting (District 7). It has been documented that there is evidence of tacit collusion between Barrett Paving and Mago Construction. There is also evidence of tacit collusion between Mago Construction and H.G. Mays and Hinkle Contracting (see Table 6.27). What is particularly amazing is that Mago Construction and H.G. Mays never bid against each other in Bracken County. Eaton Asphalt Paving competes against H.G. Mays and Mago Construction. These other firms could reasonably bid on projects and bid levels for the single-bid contracts are \$166,348.13 above the competitive level.

Mago Construction has plants located in Pendleton County. Eaton Asphalt Paving and Mago Construction actively bid on the nine projects in Pendleton County. The contracted value of these nine projects is \$3,421,803.73. There are five single-bid contracts and these projects average 0.08 percent above the engineer's estimate. The other four multi-bid projects average 13.59 percent below the engineer's estimate (see Table 6.24). The potential competitors in Pendleton County besides the firms that bid include Barrett Paving, Bluegrass Paving, Ohio Valley Asphalt, H.G. Mays (District 5), Hinkle Contracting (District 7), and Nally & Gibson Georgetown (District 7). As detailed in the discussion about Bracken County, Mago Construction tacitly colludes with Barrett Paving, H.G. Mays, Hinkle Contracting, and Nally & Gibson Georgetown. Most interesting is Barrett Paving and Mago Construction. It is clear these firms just stick to bidding within their own respective counties of Grant and Pendleton (see Table 6.27). This coordination of bid results in bid levels that are \$294,717.48 above the competitive level.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 6 is very competitive similar to District 5. While the bidding is competitive and keeps bid levels low, there is still evidence of tacit collusion in these counties. There is evidence of tacit collusion in each one of these counties. In Boone, Campbell, Grant and Kenton County the impact of this tacit collusion on bid prices is negligible. Two things could be occurring. Firms could avoid bidding in these four counties because it is so competitive and they know they will lose money if they win the project. Also, firms could be maintaining their collusive agreements across all counties and even in competitive counties. There are still counties like Harrison County where firms do not bid and Hinkle Contracting can increase prices like a monopolist. Where tacit collusion does impact bid levels it results in bids that are \$845,722.12 above the competitive bid level for District 6. This tacit collusion results in single-bid contracts that are well above the competitive level.

Table 6.24: Summary of Tacit Collusion for District 6 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Harrison				7	\$ 2,581,285.95	3.73	Yes	Eight Firms (A)	\$ 504,899.53
Owen	6	\$ 1,767,717.10	-13.48	1	\$ 629,368.90	2.89	Yes	Eight Firms (B)	\$ 117,817.86
Robertson	4	\$ 475,851.38	-19.68	1	\$ 263,149.60	-5.53	Yes	Eight Firms (C)	\$ 27,104.41
TOTAL (WITHOUT ASPHALT PLANTS)	10	\$ 2,243,568.48	-15.96	9	\$ 3,473,804.45	2.61			
WITH ASPHALT PLANTS									
Boone	17	\$ 4,436,877.11	-16.27				Yes	Four Firms (D)	Competitive
Bracken	6	\$ 976,928.23	-15.28	3	\$ 1,415,728.80	-4.08	Yes	Four Firms (E)	\$ 166,348.13
Campbell	15	\$ 3,459,520.00	-17.75				Yes	Two Firms (F)	Competitive
Carroll	1	\$ 214,163.00	-13.20	8	\$ 1,704,494.90	2.96	Yes	Three Firms (G)	\$ 320,274.59
Gallatin	4	\$ 858,039.21	-12.14	2	\$ 305,804.00	-3.64	Yes	Five Firms (H)	\$ 37,277.51
Grant	9	\$ 2,970,340.01	-17.15				Yes	Six Firms (I)	Competitive
Kenton	18	\$ 5,562,071.10	-14.74	1	\$ 257,550.00	-26.33	Yes	Three Firms (J)	Competitive
Pendleton	4	\$ 1,569,399.70	-13.59	5	\$ 1,852,404.03	0.08	Yes	Five Firms (I)	\$ 294,717.48
TOTAL (WITH ASPHALT PLANTS)	74	\$ 20,047,338.36	-15.81	19	\$ 5,535,981.73	-1.15			
TOTAL (DISTRICT 6)	84	\$ 22,290,906.84	-15.83	28	\$ 9,009,786.18	0.06			\$845,722.12

(A) These firms include The Allen Company, ATS Construction, Barrett Paving, Hinkle Contracting, Lexington Quarry, Mago Construction, Nally & Gibson Georgetown, and The Walker Company

(B) These firms include ATS Construction, Barrett Paving, Commercial Pavers, Eaton Asphalt Paving, H.G. Mays, Mago Construction, Nally & Gibson Georgetown, and Ohio Valley Asphalt

(C) These firms include The Allen Company, Barrett Paving, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company

(D) These firms include Barrett Paving, Eaton Asphalt Paving, Mago Construction, and Ohio Valley Asphalt

(E) These firms include Barrett Paving, H.G. Mays, Hinkle Contracting, and Mago Construction

(F) These firms include Barrett Paving and H.G. Mays

(G) These firms include Commercial Pavers, Eaton Asphalt Paving, and Ohio Valley Asphalt

(H) These firms include Eaton Asphalt Paving, H.G. Mays, Mago Construction, Nally & Gibson Georgetown, and Ohio Valley Asphalt

(I) These firms include ATS Construction, Barrett Paving, H.G. Mays, Hinkle Contracting, Mago Construction, and Nally & Gibson Georgetown

(J) These firms include Eaton Asphalt Paving, Mago Construction, and Ohio Valley Asphalt

Table 6.25: Summary Statistics for District 6 Firms

VARIABLES	Barrett Paving		Bluegrass Paving		Eaton Asphalt Paving		Mago Construction		Ohio Valley Asphalt	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.346	0.477	0.230	0.422	0.406	0.492	0.179	0.384	0.143	0.351
Distance Variables										
Distance (0 to 10 miles) [reference variable]	0.148	0.356	0.104	0.306	0.143	0.351	0.0684	0.253	0.0606	0.239
Distance (11 to 20 miles)	0.170	0.377	0.230	0.422	0.123	0.329	0.219	0.414	0.160	0.368
Distance (21 to 30 miles)	0.137	0.345	0.126	0.333	0.176	0.382	0.281	0.45	0.117	0.322
Distance (31 to 40 miles)	0.148	0.356	0.148	0.357	0.164	0.371	0.167	0.373	0.169	0.375
Distance (41 to 50 miles)	0.121	0.327	0.185	0.39	0.201	0.401	0.132	0.338	0.221	0.416
Distance (51 to 60 miles)	0.275	0.448	0.207	0.407	0.193	0.395	0.133	0.34	0.273	0.446
Other Control Variables										
Jobs Under Contract	0.769	1.062	0.393	0.534	4.635	2.007	6.147	2.196	1.359	1.304
Engineer's Estimate	491,497	1.67E+06	321,667	2.00E+05	403,471	8.10E+05	638,763	1.62E+06	504,737	8.76E+05
Competitive Variables										
Number of Competitor Service Areas	9.890	3.153	8.874	2.869	8.934	2.959	8.968	3.021	9.788	3.121
Zero other competitive bid proposal purchased [reference variable]	0	-	0	-	0.00410	0.064	0.0544	0.227	0.0433	0.204
One other competitive bid proposal purchased	0.516	0.501	0.259	0.44	0.672	0.47	0.446	0.497	0.273	0.446
Two other competitive bid proposals purchased	0.418	0.495	0.615	0.488	0.270	0.445	0.302	0.459	0.225	0.419
Three or more other competitive bid proposals purchased	0.0659	0.249	0.126	0.333	0.0533	0.225	0.198	0.399	0.459	0.499
County Variables										
Project in same county-no rival	0.132	0.339	0	-	0.0246	0.155	0.128	0.334	0.0779	0.269
Project in same county-rival	0.0934	0.292	0.126	0.333	0.0861	0.281	0.0105	0.102	0	-
Project in adjacent county-no rival [reference variable]	0.242	0.429	0.289	0.455	0.320	0.467	0.277	0.448	0.195	0.397
Project in adjacent county-rival	0.533	0.5	0.585	0.495	0.570	0.496	0.584	0.493	0.727	0.446
Observations	182		135		244		570		231	

Table 6.26: Regression results for District 6 Firms

VARIABLES	Barrett Paving		Bluegrass Paving		Eaton Asphalt Paving		Mago Construction		Ohio Valley Asphalt	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.00590 (0.0637)	0.0156 (0.0572)	-0.255* (0.133)	-0.227* (0.134)	-0.0491 (0.0808)	-0.0666 (0.0839)	-0.454*** (0.0581)	-0.249*** (0.0635)	-0.468*** (0.105)	-0.00301 (0.0828)
Distance (21 to 30 miles)	-0.591*** (0.112)	-0.379*** (0.117)	-0.544*** (0.139)	-0.428** (0.167)	-0.245*** (0.0937)	-0.185* (0.0972)	-0.727*** (0.0514)	-0.425*** (0.0716)	-0.606*** (0.110)	-0.0681 (0.117)
Distance (31 to 40 miles)	-0.897*** (0.0579)	-0.653*** (0.0904)	-0.773*** (0.114)	-0.659*** (0.144)	-0.392*** (0.101)	-0.323*** (0.106)	-0.829*** (0.0478)	-0.505*** (0.0724)	-0.693*** (0.0985)	-0.162 (0.103)
Distance (41 to 50 miles)	-0.885*** (0.0656)	-0.624*** (0.0967)	-0.768*** (0.119)	-0.683*** (0.139)	-0.761*** (0.0750)	-0.687*** (0.0840)	-0.862*** (0.0479)	-0.515*** (0.0742)	-0.776*** (0.0872)	-0.271*** (0.101)
Distance (51 to 60 miles)	-0.884*** (0.0653)	-0.608*** (0.104)	-0.746*** (0.124)	-0.651*** (0.147)	-0.778*** (0.0717)	-0.707*** (0.0793)	-0.889*** (0.0491)	-0.545*** (0.0763)	-0.811*** (0.0871)	-0.294*** (0.103)
Jobs Under Contract	-0.00269 (0.0193)	-0.00561 (0.0179)	-0.157*** (0.0582)	-0.151** (0.0594)	0.00779 (0.0103)	0.00848 (0.0102)	0.00350 (0.00440)	0.00231 (0.00360)	0.000483 (0.0113)	0.000756 (0.0100)
Engineer's Estimate	9.46e-10 (1.48e-09)	1.99e-09 (1.82e-09)	2.10e-07 (1.38e-07)	2.04e-07 (1.33e-07)	-4.82e-08*** (1.78e-08)	-4.49e-08*** (1.63e-08)	-4.65e-10 (3.30e-09)	2.63e-09 (2.38e-09)	-2.42e-08* (1.29e-08)	-1.23e-08 (1.09e-08)
Potential Competitors	-0.0149 (0.0104)	-0.0169** (0.00835)	0.00292 (0.0130)	0.00313 (0.0132)	-0.0168** (0.00802)	-0.0172** (0.00816)	-0.0188*** (0.00492)	-0.0114*** (0.00415)	-0.00961 (0.00584)	-0.00653 (0.00499)
One competitive bid proposal purchased	0.0373 (0.0493)	0.0170 (0.0475)	0.111 (0.0781)	0.115 (0.0790)	-0.241*** (0.0803)	-0.0253 (0.0457)	-0.470*** (0.0552)	-0.189*** (0.0620)	-0.412*** (0.105)	-0.258** (0.117)
Two competitive bid proposals purchased	-0.00684 (0.0344)	-0.0206 (0.0446)	0.188** (0.0769)	0.196** (0.0793)	-0.108 (0.0779)	0.102 (0.0686)	-0.510*** (0.0574)	-0.214*** (0.0679)	-0.455*** (0.103)	-0.315*** (0.116)
Three or more competitive bid proposals purchased					-0.282** (0.109)	-0.0486 (0.0940)	-0.632*** (0.0572)	-0.273*** (0.0709)	-0.601*** (0.0964)	-0.436*** (0.109)
Project in same county-rival		-0.0460 (0.0377)				-0.109* (0.0656)		0.182** (0.0715)		
Project in adjacent county-no rival		-0.276*** (0.0736)		-0.0974 (0.134)		-0.300*** (0.0877)		-0.380*** (0.0842)		-0.520*** (0.105)
Project in adjacent county-rival		-0.380*** (0.104)		-0.173 (0.146)		-0.310*** (0.0878)		-0.527*** (0.0793)		-0.638*** (0.0949)
Constant	1.044*** (0.0526)	1.179*** (0.0644)	0.592*** (0.133)	0.640*** (0.166)	1.162*** (0.102)	1.180*** (0.108)	1.488*** (0.0811)	1.278*** (0.0735)	1.394*** (0.114)	1.294*** (0.107)
Observations	182	182	135	135	244	244	570	570	231	231
R-squared	0.803	0.841	0.536	0.547	0.557	0.572	0.577	0.692	0.585	0.665

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.27: Additional regression results for District 6 firms and firms outside District 6

VARIABLES	Barrett Paving			Bluegrass Paving			Eaton Asphalt Paving			Mago Construction			Ohio Valley Asphalt		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	-0.0460 (0.0377)	-0.0894** (0.0412)	0.0267 (0.0330)				-0.109* (0.0656)	-0.145** (0.0656)	-0.0173 (0.0277)	0.182** (0.0715)	0.143* (0.0767)	0.423*** (0.0733)			
Project in adjacent county-no rival	-0.276*** (0.0736)	-0.334*** (0.0727)		-0.0974 (0.134)	-0.0758 (0.139)		-0.300*** (0.0877)	-0.431*** (0.0902)		-0.380*** (0.0842)	-0.296*** (0.0842)		-0.520*** (0.105)	-0.00685 (0.116)	
Project in adjacent county-rival	-0.380*** (0.104)		-0.863*** (0.0782)	-0.173 (0.146)	-0.248 (0.202)		-0.310*** (0.0878)	-0.346*** (0.0880)		-0.527*** (0.0793)		-0.364*** (0.0605)	-0.638*** (0.0949)		-0.229*** (0.0679)
Project in adjacent county-Allen Company										-0.314*** (0.0822)					
Project in adjacent county-ATS Construction		-0.352*** (0.0790)						-0.462*** (0.0806)			-0.427*** (0.0827)			0.0446 (0.123)	
Project in adjacent county-Barrett Paving					-0.216 (0.176)			-0.0267 (0.0675)			-0.449*** (0.100)			-0.0668 (0.120)	
Project in adjacent county-Bluegrass Paving											0.316*** (0.101)			0.267 (0.180)	
Project in adjacent county-Commercial Pavers											-0.699*** (0.0842)			-0.522*** (0.0979)	
Project in adjacent county-Eaton Asphalt Paving		-0.193 (0.246)			-0.328 (0.207)						-0.308*** (0.0825)			-0.392** (0.181)	
Project in adjacent county-HG Mays		-0.289** (0.116)			0.0848 (0.173)			-0.533*** (0.116)			-0.383*** (0.0780)			-0.00697 (0.129)	
Project in adjacent county-Hinkle Contracting		-0.401*** (0.0788)						-0.650*** (0.111)			-0.384*** (0.0808)				
Project in adjacent county-Lexington Quarry											-0.479*** (0.0857)				
Project in adjacent county-Mago Construction		-0.550*** (0.101)			-0.146 (0.144)			-0.405*** (0.119)						0.0730 (0.122)	
Project in adjacent county-Nally & Gibson Georgetown		-0.364*** (0.0819)			-0.0972 (0.155)			-0.412*** (0.0782)			-0.361*** (0.0849)			0.0525 (0.120)	
Project in adjacent county-Ohio Valley Asphalt		-0.520*** (0.0979)			-0.0726 (0.146)			-0.737*** (0.113)			-0.475*** (0.0853)				
Project in adjacent county-Walker Company								-0.577*** (0.101)			-0.298*** (0.0845)				
Project in Harrison County			-0.886*** (0.0739)			-0.277 (0.206)			-0.406*** (0.110)			-0.382*** (0.0658)			-0.289*** (0.0748)
Project in Owen County			-0.930*** (0.0647)			-0.215 (0.213)			0.0505 (0.166)			0.395*** (0.141)			0.0706 (0.228)
Project in Robertson County			-0.854*** (0.0796)			-0.169 (0.233)			-0.442* (0.245)			-0.158 (0.204)			
Constant	1.179*** (0.0644)	1.317*** (0.101)	1.023*** (0.0476)	0.640*** (0.166)	0.635*** (0.177)	0.583*** (0.143)	1.180*** (0.108)	1.309*** (0.120)	1.096*** (0.0972)	1.278*** (0.0735)	1.264*** (0.0818)	1.227*** (0.0737)	1.294*** (0.107)	1.367*** (0.0911)	1.241*** (0.133)
Observations	182	182	182	135	135	135	244	244	244	570	570	570	231	231	231
R-squared	0.841	0.863	0.900	0.547	0.555	0.553	0.572	0.666	0.642	0.692	0.710	0.773	0.665	0.727	0.640

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.27 (continued)

VARIABLES	Commercial Pavers (District 5)			Flynn Brothers (District 5)			HG Mays (District 5)			The Allen Company (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival							0.128 (0.0996)	0.252** (0.117)	0.218* (0.111)	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)
Project in adjacent county-no rival	-0.764*** (0.116)	-0.737*** (0.107)		-0.0619 (0.407)	-0.115 (0.386)		-0.653*** (0.133)	-0.408*** (0.144)		-0.177*** (0.0637)	-0.142** (0.0576)	
Project in adjacent county-rival	-0.754*** (0.109)		-0.760*** (0.112)	0.00133 (0.406)		0.00249 (0.410)	-0.729*** (0.133)		-0.374*** (0.128)	-0.424*** (0.0671)		-1*** (0)
Project in adjacent county-Allen Company		-0.751*** (0.119)			-0.166 (0.390)			-0.406*** (0.148)				
Project in adjacent county-ATS Construction		-0.715*** (0.119)						-0.546*** (0.155)			-0.678*** (0.0720)	
Project in adjacent county-Barrett Paving								-0.466*** (0.144)			-0.251*** (0.0778)	
Project in adjacent county-Bluegrass Paving								0.458*** (0.148)				
Project in adjacent county-Commercial Pavers								-0.433*** (0.146)				
Project in adjacent county-Eaton Asphalt Paving		-0.761*** (0.113)						-0.450*** (0.145)				
Project in adjacent county-HG Mays		-0.784*** (0.113)			-0.0168 (0.390)						-0.244*** (0.0645)	
Project in adjacent county-Hinkle Contracting								-0.541*** (0.141)			-0.385*** (0.0683)	
Project in adjacent county-Lexington Quarry		-0.728*** (0.116)						-0.499*** (0.148)			-0.445*** (0.0693)	
Project in adjacent county-Mago Construction		-0.784*** (0.103)			-0.0554 (0.386)			-0.420*** (0.151)			-0.331*** (0.0765)	
Project in adjacent county-Nally & Gibson Georgetown		-0.741*** (0.122)						-0.538*** (0.156)			-0.247*** (0.0651)	
Project in adjacent county-Ohio Valley Asphalt		-0.839*** (0.0983)			0.0502 (0.386)			-0.450*** (0.144)				
Project in adjacent county-Walker Company								-0.516*** (0.141)			-0.392*** (0.0685)	
Project in Harrison County									-0.366*** (0.130)			-1*** (0)
Project in Owen County			-0.830*** (0.131)						-0.404*** (0.130)			-1*** (0)
Project in Robertson County									0.498*** (0.138)			-1*** (0)
Constant	0.890*** (0.0841)	0.927*** (0.0953)	0.850*** (0.104)	0.605*** (0.150)	0.560*** (0.166)	0.598*** (0.168)	1.210*** (0.0723)	1.306*** (0.0974)	1.119*** (0.0535)	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)
Observations	202	202	202	165	165	165	373	373	373	336	336	336
R-squared	0.663	0.716	0.665	0.435	0.445	0.436	0.667	0.665	0.764	0.788	0.834	1.000

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.27 (continued)

VARIABLES	ATS Construction (District 7)			Hinkle Contracting (District 7)			Lexington Quarry (District 7)			Nally & Gibson Georgetown (District 7)			The Walker Company (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival															
Project in adjacent county-no rival	-0.300 (0.198)	-0.290 (0.204)		-0.277*** (0.0693)	-0.244*** (0.0650)		-0.177 (0.195)	0.0911 (0.259)		-1*** (0)	0* (0)		0.0786 (0.0561)	0.0776 (0.0580)	
Project in adjacent county-rival	-0.314 (0.196)		-0.332* (0.198)	-0.356*** (0.0769)		-0.683*** (0.111)	-0.254 (0.192)	-0.283 (0.195)		-1*** (0)	0*** (0)		0.124 (0.0785)		0.00635 (0.00713)
Project in adjacent county-Allen Company		-0.311 (0.201)			-0.341*** (0.0759)			0.0637 (0.259)			0* (0)			0.101 (0.0748)	
Project in adjacent county-ATS Construction					-0.391*** (0.0843)			-0.278 (0.198)			0** (0)			0.0850 (0.0859)	
Project in adjacent county-Barrett Paving		-0.287 (0.203)			-0.262*** (0.0667)			0.0483 (0.260)			0* (0)			0.0635 (0.0623)	
Project in adjacent county-Bluegrass Paving		-0.0129 (0.00795)			0.0248 (0.0657)						-0 (0)				
Project in adjacent county-Commercial Pavers											0 (0)				
Project in adjacent county-Eaton Asphalt Paving					-0.0134 (0.0633)						0 (0)			-0.00610 (0.0268)	
Project in adjacent county-HG Mays		-0.308 (0.201)			-0.318*** (0.0726)			0.00508 (0.265)			0* (0)			0.0856 (0.0752)	
Project in adjacent county-Hinkle Contracting		-0.299 (0.203)						0.0761 (0.259)			0* (0)			0.167* (0.0981)	
Project in adjacent county-Lexington Quarry		-0.339* (0.201)			-0.328*** (0.0749)						0* (0)			0.110 (0.0743)	
Project in adjacent county-Mago Construction		-0.306 (0.202)			-0.300*** (0.0706)			0.0270 (0.261)			0* (0)			0.0825 (0.0626)	
Project in adjacent county-Nally & Gibson Georgetown		-0.331* (0.200)			-0.354*** (0.0791)			0.00107 (0.267)			0 (0)			0.102 (0.0716)	
Project in adjacent county-Ohio Valley Asphalt		-0.299 (0.202)									0* (0)				
Project in adjacent county-Walker Company		-0.293 (0.202)			-0.395*** (0.0832)			0.0810 (0.255)			0* (0)				
Project in Harrison County			-0.338* (0.199)			-0.00140 (0.0254)		-0.286 (0.196)			0*** (0)				0.00149 (0.00718)
Project in Owen County			-0.323 (0.199)			-0.662*** (0.119)		-0.277 (0.191)			0*** (0)				
Project in Robertson County			-0.324 (0.198)			-0.272 (0.252)		-0.278 (0.192)			0*** (0)				-0.00172 (0.00640)
Constant	0.983*** (0.0286)	0.955*** (0.0549)	1.005*** (0.0150)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	0.975*** (0.107)	0.936*** (0.163)	1.133*** (0.0930)	1*** (0)	1*** (0)	1*** (0)	1.014*** (0.0105)	0.975*** (0.0227)	1.005*** (0.00721)
Observations	283	283	283	531	531	531	239	239	239	270	270	270	245	245	245
R-squared	0.883	0.884	0.888	0.892	0.893	0.942	0.702	0.739	0.852	1.000	1.000	1.000	0.869	0.874	0.888

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.27: District 6

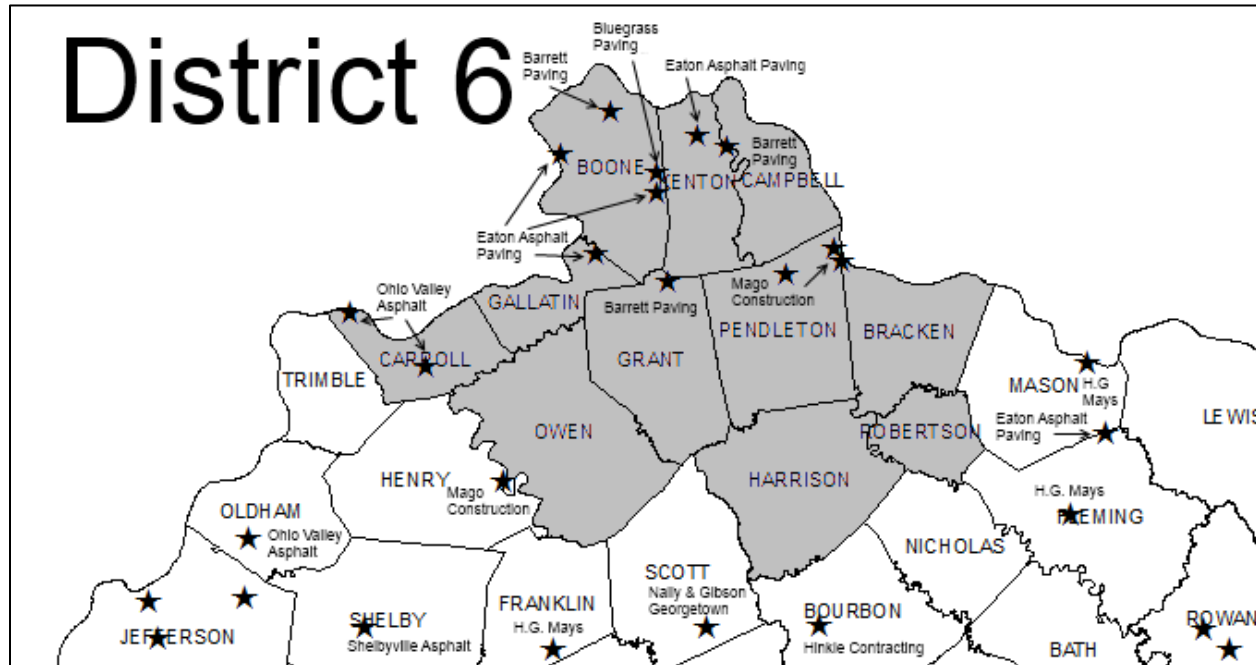


Figure 6.28: Barrett Paving Service Area

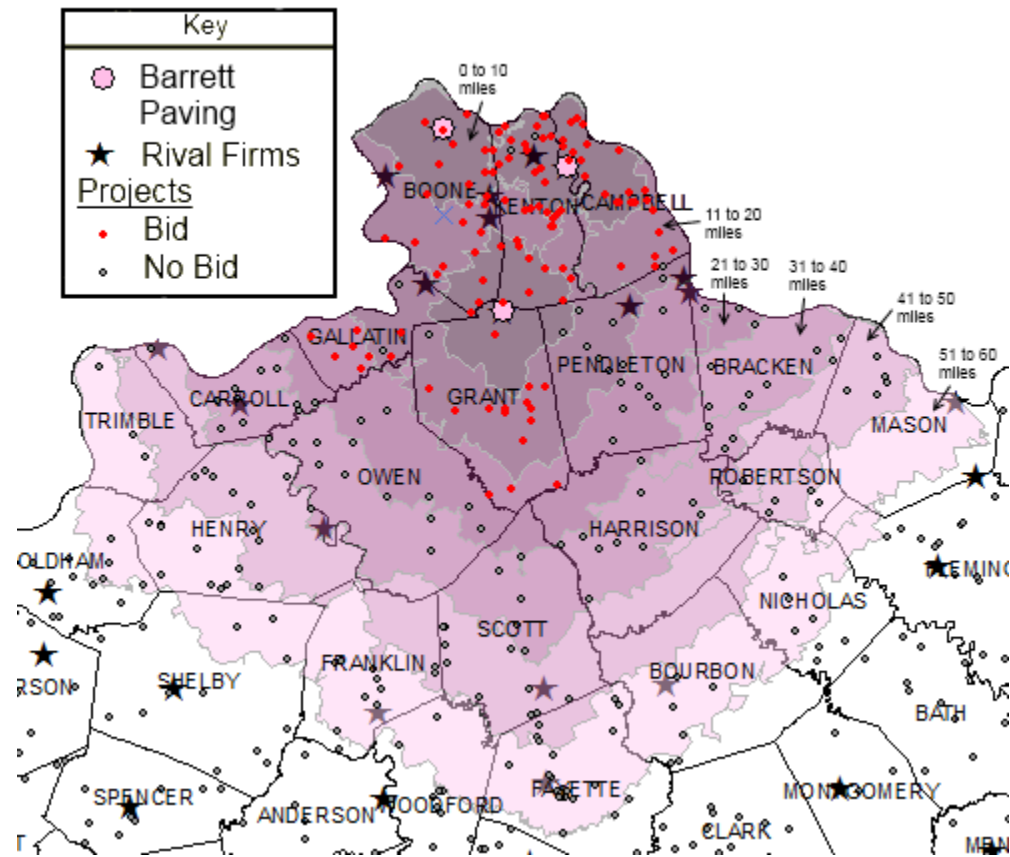


Figure 6.29: Bluegrass Paving Service Area

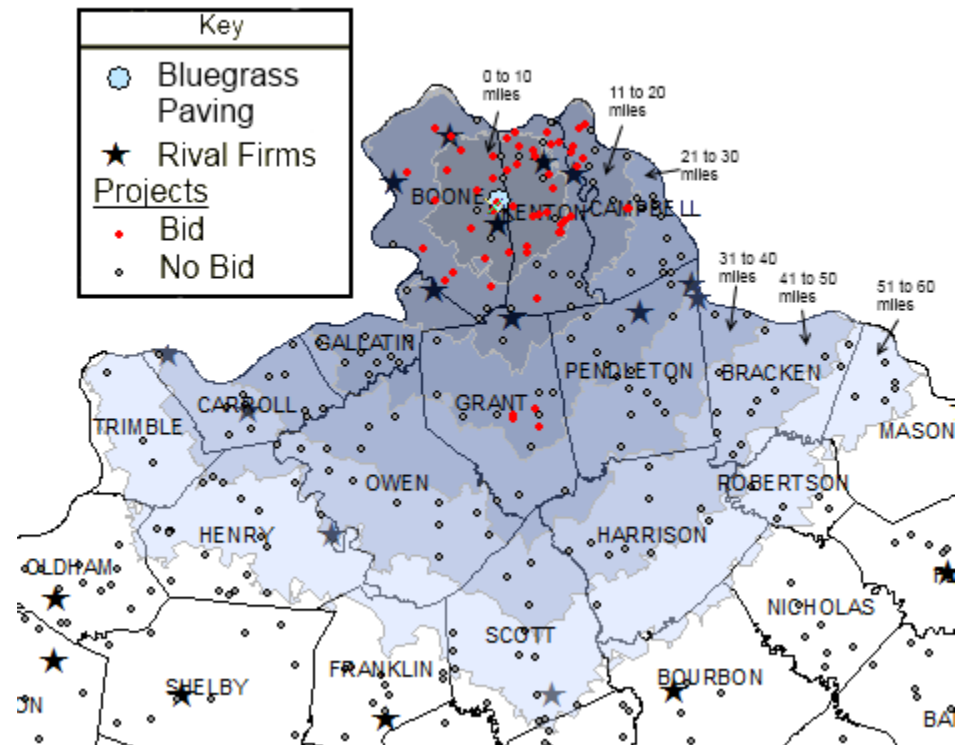


Figure 6.30: Eaton Asphalt Paving Service Area

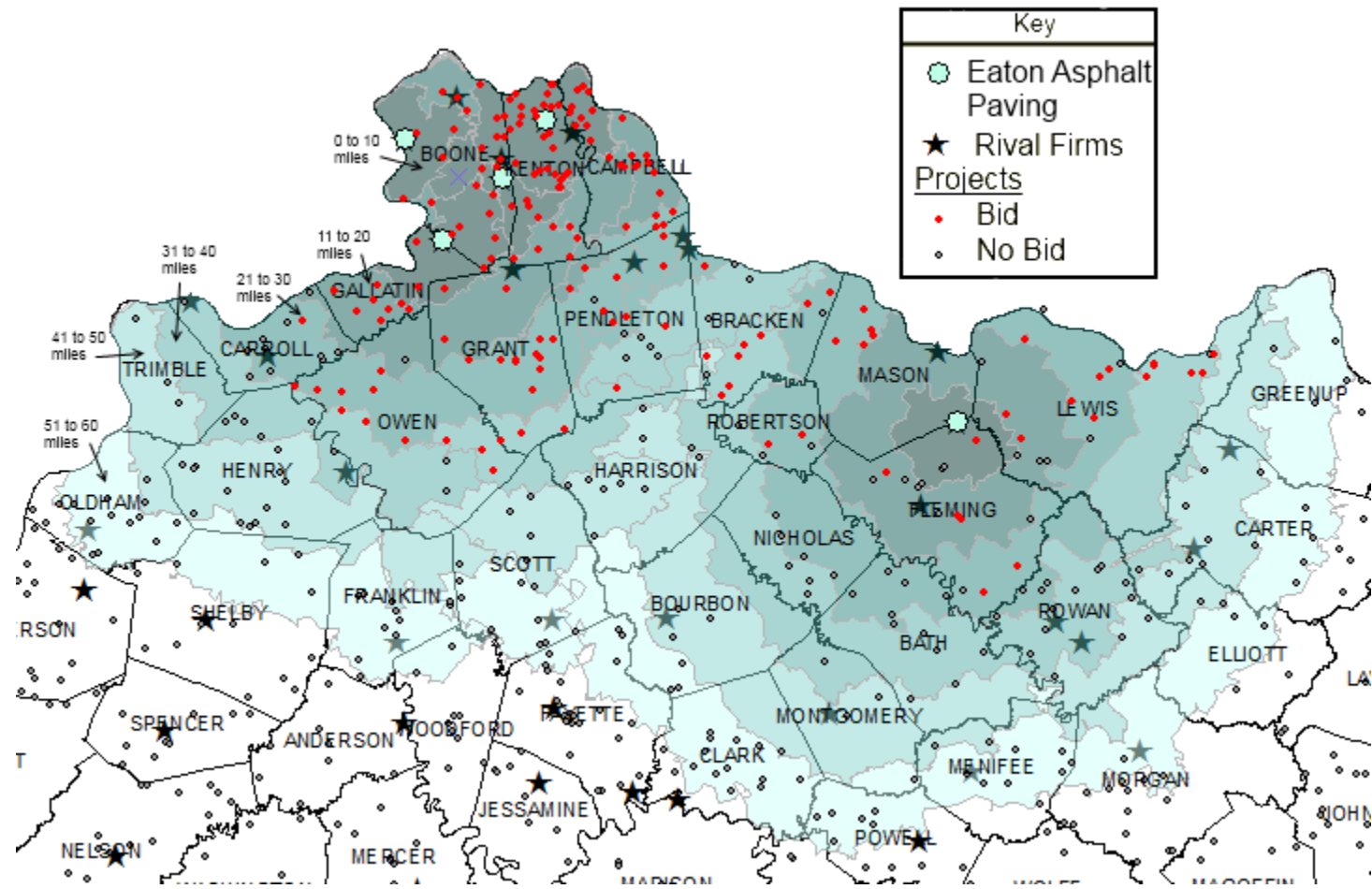


Figure 6.31: Mago Construction Service Area

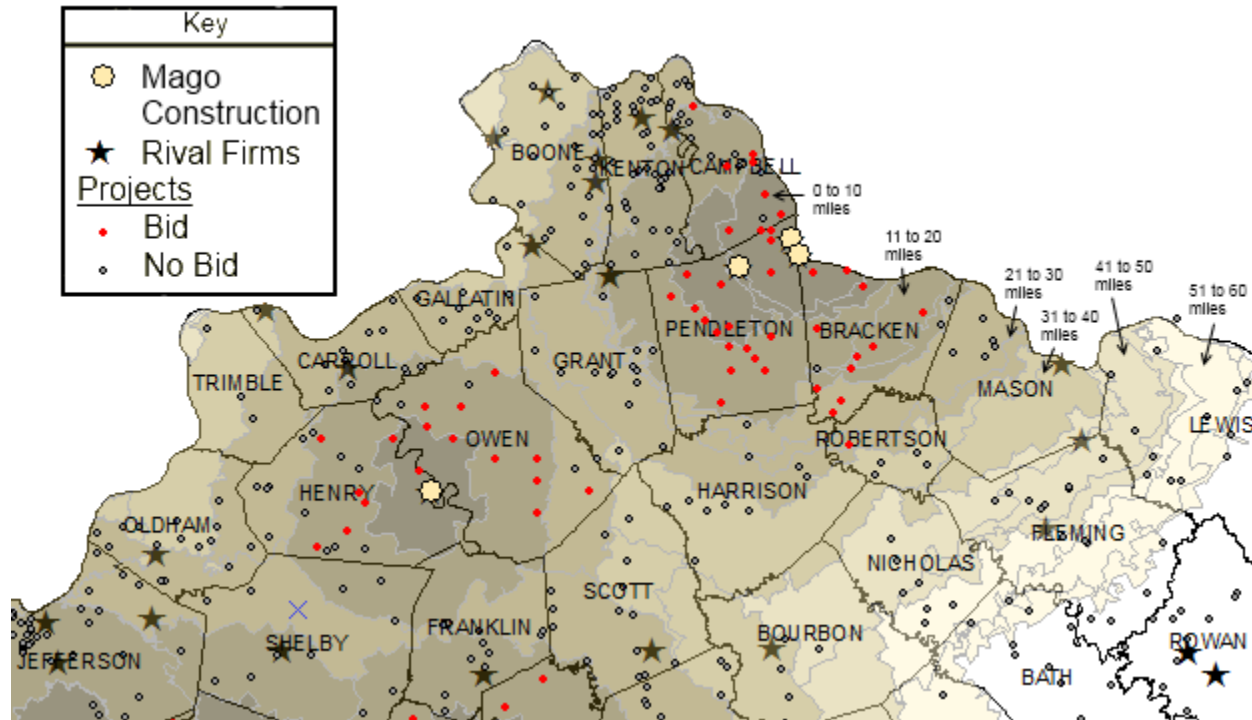
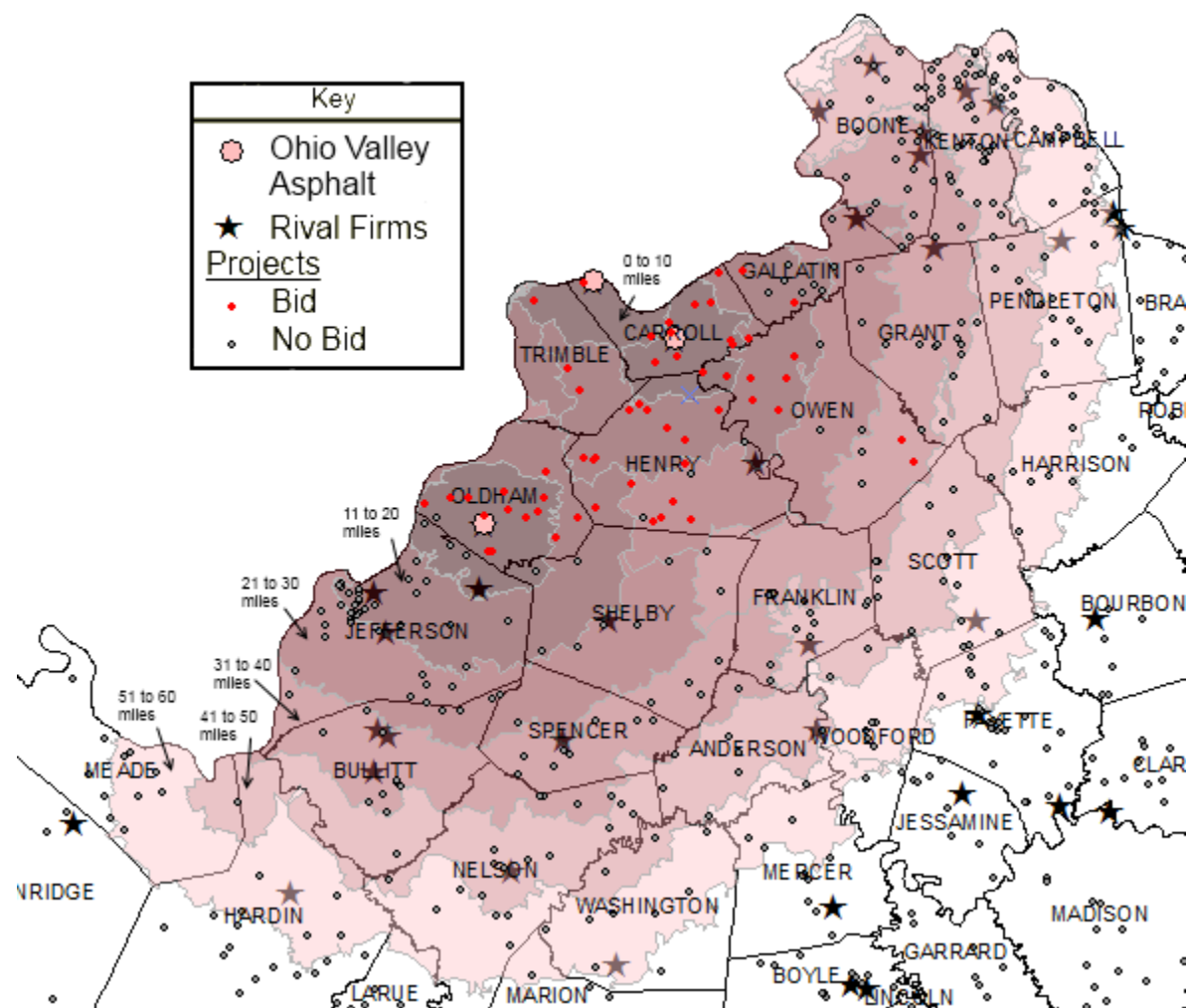


Figure 6.32: Ohio Valley Asphalt Service Area



6.8 District 7 – Central Kentucky

District 7 consists of firms in the Central Kentucky area which includes Lexington, Kentucky (see Figure 6.33). There are eight firms that have plants located in this district and that compete on projects: The Allen Company, ATS Construction, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, and The Walker Company. There is evidence of tacit collusion in all 12 counties. Three of the firms are owned by the Lawson family: The Allen Company, ATS Construction, and Lexington Quarry. These firms are not competitors and can coordinate bidding, and these firms never bid against each other. However, other firms do tacitly collude with these firms. The pattern that emerges in these counties is that firms stick to bidding in the counties where they have asphalt plants. They also avoid bidding on projects in counties where a rival firm has an asphalt plant. There is one exception where The Walker Company bids on projects in Powell County (District 10) where Hinkle Contracting has an asphalt plant. Lincoln County Ready Mix is a firm that bids aggressively against The Allen Company in Boyle and Garrard Counties. The result of this tacit collusion is that there are single-bid contracts which increase bids about \$19,378,600.55. Around \$12 million of this comes from Fayette County where ATS Construction is the lone bidder.

Projects average 2.00 percent below the engineer's estimate which is higher than the Kentucky average of 3.84 percent below the engineer's estimate. The multi-bid projects average 22.18 percent below the engineer's estimate while the single-bid projects average 2.49 percent above the engineer's estimate. What is telling about these numbers is that when firms actively bid on projects against their competitors it puts downward pressure on the bids. However, there is not much competition in this district and 99 of the 121 projects only have one bidder. An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.28, Table 6.29, Table 6.30, and Table 6.31. Additional regression analysis follows these figures as well as maps for each firm. The additional regression results which appear after the regression results in Table 6.31 include all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.8.1 Firms with Asphalt Plants in District 7

THE ALLEN COMPANY

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

The Allen Company has three asphalt plants located in District 7. They do not bid against ATS Construction (Fayette) and Lexington Quarry (Jessamine) because these three firms are all owned by the same company. They have two plants in Madison County and one in Boyle County. Their primary competitors are Elmo Greer & Sons, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Haydon Surfacing, and The Walker Company. They bid on 54 projects in Kentucky and 43 of them are in District 7. They were awarded 38 of the 43 projects. The contracted value of all of the 43 projects was \$13,954,822.28. The average number of bidders on these projects was 1.42 bidders. Twenty-six of the 43 projects were only bid on by The Allen Company. The 26 single-bid contracts averaged 0.22 percent below the engineer's estimate, while the multi-bid projects averaged 24.36 below the engineer's estimate.

FIRM BID FUNCTION

The bid function for The Allen Company is in Table 6.30. Without the county variables, it indicates that once a project gets beyond 10 miles, the probability of The Allen Company bidding on a project diminishes significantly. However, when the county variables are added this extends out to beyond 20 miles. The more projects they have under contract the less likely they are going to bid on a project under both specifications. The competitor variables are also negative and significant. They are less likely to bid on a project as the number of potential competitors increases, and when a competitor purchases a bid proposal they are less likely to bid on it as opposed to when they are the only one purchasing a bid proposal. When the county variables are added, the variable for projects in the counties where The Allen Company has an asphalt plant is positive and significant. They are less likely to bid on projects in adjacent counties. The "Project in adjacent county-rival" is negative and significant and the magnitude is greater than "Project in adjacent county-no rival." In the additional regressions in Table 6.31, they are less likely to bid on projects in counties where ATS Construction, Barrett Paving, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lexington Quarry, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, Shelbyville Asphalt and The Walker Company have asphalt plants. They are also less likely to bid on projects in Woodford County. They treat

bids in Clark and Garrard Counties like they treat bids in Madison County where they have their asphalt plants. More of their bidding behavior will be explored in the “Counties” section.

ATS CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

ATS Construction has two asphalt plants located in Fayette County in District 7. As noted earlier, they are owned by the same family that owns The Allen Company and Lexington Quarry. These three firms can coordinate bidding and avoid bidding against each other. What is interesting is that this same behavior occurs between ATS Construction and their competitors. Their primary competitors are H.G. Mays, Hinkle Contracting, Mago Construction, and Nally & Gibson Georgetown. They bid on 21 projects in Kentucky and they are all located in District 7. Twenty of them are located in Fayette County and the other one is located in Woodford County. They were awarded all 21 projects. The contracted value of all of the 21 projects was \$39,934,777.30. The average number of bidders on these projects was 1.00 bidders meaning that ATS Construction was the only bidder on all 21 projects. The 21 single-bid contracts averaged 7.12 percent above the engineer’s estimate. It is interesting that ATS Construction is surrounded by competition, but they were the only bidder on more than \$39 million worth of projects. The factors that influence their bidding on projects will be explored in the next section.

FIRM BID FUNCTION

The bid function for ATS Construction is in Table 6.30. Without the county variables, it indicates that distance does impact whether or not ATS Construction bids on a project. When the county variables are added in specification B this effect goes away. This is not surprising since they bid on only one project outside of Lexington in Fayette County. Out of the 21 projects they bid on, only three of the projects had more than one other competitor purchase a bid proposal. They are less likely to bid on projects where another firm purchases a bid proposal. Not surprisingly, the county variables are not significant either. There is multicollinearity between the bid proposal variables and the county variables. Therefore it is important to focus on the ATS Construction map in determining if they are tacitly colluding with their rivals (see Figure 6.35). This is a case where their focus is almost entirely in Fayette County. They have enough projects to sustain their business and the other firms, for the most part, allow them to be the only bidder on the projects. Like Road Builders in District 2, the regression for ATS Construction suffers multicollinearity and cannot be used in the analysis the same way I use it for the other firms.

The other firms that purchased bid proposals or bid on projects in Fayette County was Lexington Quarry who is part of the same company as ATS Construction. All other firms let ATS Construction be the lone bidder. When specific firms were added into the additional regressions, only the coefficient for Lexington Quarry is negative and significant. When the variables for adjacent counties without rival firms were included the “Projects in adjacent county-rival” is now significant and negative. They also avoid bidding on projects in Clark County. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the “Counties” section.

HINKLE CONTRACTING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Hinkle Contracting has one of their 11 asphalt plants located in Bourbon County in District 7. They also have asphalt plants located in counties that border District 7. Their primary competitors in District 7 are The Allen Company, ATS Construction, Nally & Gibson Georgetown, and The Walker Company. They bid on 107 projects in Kentucky and seven of those projects are located in Bourbon County in District 7. They were awarded all seven projects. The contracted value of all of the seven projects was \$2,022,283.40. The average number of bidders on these projects was 1.00 bidders meaning that Hinkle Contracting was the only bidder on all seven projects. The seven single-bid contracts averaged 0.97 percent above the engineer’s estimate. The factors that influence their bidding on projects will be explored in the next section.

FIRM BID FUNCTION

The bid function for The Hinkle Contracting is in Table 6.30. Without the county variables, it indicates that once a project gets beyond 20 miles, the probability of Hinkle Contracting bidding on a project diminishes significantly. However, when the county variables are added the only distance variables that are significant is the Distance (11 to 20 miles and 21 to 30 miles) are positive meaning they are more likely to bid on projects in these rings than those in the 0 to 10 mile ring. All of the other distance variables are not significant. This means that when the county variables are controlled for distance is actually not that important of a factor. Competitor firms purchasing bid proposals decreases the probability of Hinkle Contracting bidding on a project. Also, as the number potential competitors increase the probability of them bidding on a project decreases. The bid proposal variables are also negative and significant. When the county variables are added, the coefficient for projects in adjacent

counties to where Hinkle Contracting has their asphalt plants is negative and significant. When specific firms and county variables were added, they are less likely to bid on projects in counties where District 7 firms have asphalt plants except for Lincoln County Ready Mix. They are also less likely to bid on projects in Clark, Garrard, and Woodford Counties. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the “Counties” section.

LEXINGTON QUARRY

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Lexington Quarry has one asphalt plant located in Jessamine County in District 7. They are owned by the Lawson family along with The Allen Company and ATS Construction. Their primary competitors in District 7 are Lincoln County Ready Mix and Mago Construction. They bid on 17 projects in Kentucky, and all of them were in District 7. They were awarded 14 of the 17 projects. The contracted value of all of the 17 projects was \$7,742,125.10. The average number of bidders on these projects was 1.24 bidders. The 13 single-bid contracts averaged 3.06 percent above the engineer’s estimate while the four multi-bid projects averaged 15.03 percent below the engineer’s estimate. The factors that influence their bidding on projects will be explored in the next section.

FIRM BID FUNCTION

The bid function for The Lexington Quarry is in Table 6.30. Without the county variables, it indicates that distance does not significantly impact whether they bid on a project. However, when the county variables are added they are less likely to bid on projects in the 31 to 40 mile and 41 to 50 mile ring than those projects 0 to 10 miles from their plant. Competitor firms purchasing bid proposals decreases the probability of Lexington Quarry bidding on a project. When the county variables are added, they are negative and not significant. Like Road Builders and ATS Construction, this results from multicollinearity. The bid proposals and county variables are correlated with each other and produce this inconclusive result. Therefore, I will rely more on the firm map in determining if Lexington Quarry is coordinating bids with other firms. More of their bidding behavior will be explored in the “Counties” section.

LINCOLN COUNTY READY MIX

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Lincoln County Ready Mix has one asphalt plant located in Boyle County in District 7. Their primary competitors are The Allen Company, Hinkle Contracting, Mago Construction, and Nally & Haydon Surfacing. They bid on 28 projects in Kentucky and 18 of them are in District 7. The other 10 are in Lincoln County in District 8. They were awarded five of the 18 projects. The contracted value of all of the 18 projects was \$4,486,514.48. The average number of bidders on these projects was 2.06 bidders. They are bidding on projects against The Allen Company and Mago Construction. The contracted value of the 18 projects averaged 23.77 percent below the engineer's estimate. It is clear they are an active bidder and since there are multiple bidders it drives the bid levels down.

FIRM BID FUNCTION

The bid function for The Lincoln County Ready Mix is in Table 6.30. Without the county variables, it indicates that once a project gets beyond 20 miles, the probability of Lincoln County Ready mix bidding on a project diminishes significantly. However, when the county variables are added in specification B, none of the distance variables are significant. The more projects Lincoln County Ready Mix has under contract the less likely they are going to bid on a project under both specifications. They are less likely to bid on a project as the number of potential competitors increases. When the county variables are added, the variable for projects in the counties adjacent to where Lincoln County Ready Mix has an asphalt plant is negative and significant. The magnitude is greater if a rival firm has an asphalt plant in the county. When specific firms are added, they are less likely to bid against ATS Construction, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lexington Quarry, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and Shelbyville Asphalt. They are also less likely to bid on projects in Clark and Woodford Counties than in Boyle County. What is interesting is that they bid against The Allen Company in Boyle, Garrard, and Madison Counties in District 7. The additional regression results in Table 6.31 support this result. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the "Counties" section.

MAGO CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mago Construction has two of their 12 plants located in District 7 located in Anderson and Mercer Counties. Their primary competitors in District 7 who have asphalt plants in these counties are The Allen Company, ATS Construction, Lexington Quarry, Lincoln County Ready Mix, and Nally & Gibson Georgetown. These two counties also border firms in other districts such as H.G. Mays and Shelbyville Asphalt, and Nally & Haydon Surfacing. They bid on 102 projects in Kentucky and 19 of those are in counties in District 7. Of those 19 bids, they were awarded 18 of the contracts. The contracted value of all of the 19 projects was \$8,475,201.01. The average number of bidders on these projects was 1.26 bidders. Fourteen of the 19 bids only had one bidder, Mago Construction, and the contracted value of these projects averaged 0.54 percent above the engineer's estimate. For the other five projects with more than one bidder, the contracted value of the projects averages 14.76 percent below the engineer's estimate. Whether or not Mago Construction is tacitly colluding will be analyzed in the "Counties" section.

FIRM BID FUNCTION

The results of the bid function for Mago Construction were discussed in detail in the District 4 section. The important points of the bid function will be highlighted here. The county variables indicate that Mago Construction is less likely to bid on a project in a county adjacent to Anderson and Mercer and the other counties where they have asphalt plants. When specific firms and counties are added, they generally are less likely to bid against these rivals. They are also less likely to bid on projects in Clark and Garrard Counties. However, they actively bid in Woodford County and it shows in the additional regression results. Distance, competitor behavior, and which county a project is located in all significantly influence whether or not Mago Construction bids on a project. More of their bidding behavior will be explored in the "Counties" section.

NALLY & GIBSON GEORGETOWN

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Nally & Gibson Georgetown has one asphalt plant located in Scotty County in District 7. Their primary competitors are ATS Construction, H.G. Mays (District 5), and Hinkle Contracting. They bid on 11 projects in Kentucky and all of them were in District 7 in Scotty County. They were awarded all 11 projects. The contracted value of all of the 11 projects was \$4,804,703.60.

The average number of bidders on these projects was 1.00 bidders. The 11 single-bid contracts averaged 1.42 percent above the engineer's estimate. They were the only firm that bid on projects in Scotty County.

FIRM BID FUNCTION

The bid function for Nally & Gibson Georgetown is in Table 6.30. It is clear that the county the project is in is the main factor on whether or not they bid on the project. This means the factor that influences their bidding is that a project is in Scott County. They just bid on projects in Scott County and that fully explains their bidding behavior. This is a pattern repeated with other firms in neighboring counties such as ATS Construction in Fayette County and Hinkle Contracting in Bourbon County. More of their bidding behavior will be explored in the "Counties" section.

THE WALKER COMPANY

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

The Walker Company of Kentucky has two asphalt plants in Kentucky with one of them located in Montgomery County in District 7. Their primary competitors are ATS Construction, The Allen Company, and Hinkle Contracting. They bid on 22 projects in Kentucky and seven of them are in District 7. They were awarded all seven projects. The contracted value of these seven projects was \$2,146,662.70. The average number of bidders on these projects was 1.00 bidders. The seven single-bid contracts averaged 4.68 percent above the engineer's estimate. Even though Hinkle Contracting has plants located in counties bordering Montgomery County they do not bid on projects.

FIRM BID FUNCTION

The bid function for The Walker Company is in Table 6.30. Without or with the county variables, none of the distance variables are significant. They are less likely to bid on a project when a competitor purchases a bid proposal. Like Road Builders and ATS Construction, these bid proposal variables are correlated with the county variables. This results in multicollinearity and the results in this regression are suspect. Therefore the map of The Walker Company's bidding behavior is used as the main source of determining if they are coordinating bids with other firms (see Figure 6.41). More of their bidding behavior will be explored in the "Counties" section.

6.8.2 *Counties in District 7*

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.31). The additional regressions for firms outside District 7 are found in Table 6.31. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.30). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

CLARK COUNTY

There are a total of 12 projects in Clark County, and only one bidder, The Allen Company, bids on the projects. The total contracted value of these projects is \$4,360,402.95. The project's contracted value averages 0.67 percent above the engineer's estimate. The average for competitive bids for District 7 projects is 22.18 percent below the engineer's estimate (see Table 6.28). The other potential bidders for projects in Clark County include ATS Construction, Lexington Quarry, Lincoln County Ready Mix, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company, all firms in District 7. However, ATS Construction and Lexington Quarry are not competitors to The Allen Company and therefore not involved in tacit collusion. Potential competitors for projects in Clark County outside District 7 include H.G. Mays (District 5 and 9) and Elmo Greer & Sons (District 8 and 11). A variable for Clark County was added in to the regressions for these firms (see Table 6.31). Of these firms Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, The Walker Company, H.G. Mays, and Elmo Greer Sons are less likely to bid on projects in Clark County, and in turn The Allen Company is less likely to bid on projects in these firm's counties. There is evidence of tacit collusion. Firms refrain from bidding against The Allen Company, which is the only bidder in Clark County. In the rest of Kentucky The Allen Company does not bid against these firms. This coordination of bids results in bid levels that average 21.51 percent or \$937,922.67 above the competitive level.

GARRARD COUNTY

There are a total of nine projects in Garrard County. The total contracted value of these projects is \$2,460,235.70 and the contracted value for all projects averages 16.43 percent below the engineer's estimate. Three of the nine projects only have one bidder and average 3.75 percent above the engineer's estimate. There are two firms that bid regularly on projects in Garrard County: The Allen Company and Lincoln County Ready Mix. Both firms have plants in Boyle County while The Allen Company has two plants in Madison County. The other potential competitors from District 7 include Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company. Other firms include Nally & Haydon Surfacing (District 4), H.G. Mays (District 5), and Elmo Greer & Sons (District 8 and 11). A variable for Garrard County was added to the additional regressions. Those firms that are less likely to bid on projects in Garrard County include Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, The Walker Company, Nally & Haydon Surfacing (District 4), H.G. Mays (District 5), and Elmo Greer & Sons (District 8 and 11). In turn The Allen Company and Lincoln County Ready Mix do not bid in these firms counties (see Table 6.31). The one exception is that Lincoln Ready Mix is not within a reasonable distance to bid on projects in counties where The Walker Company has an asphalt plant.

There is evidence of tacit collusion is occurring in Garrard County. While The Allen Company and Lincoln County Ready Mix actively bid against each other, other firms refrain from bidding in Garrard County and in turn The Allen Company and Lincoln County Ready Mix do not bid in their counties. If these firms bid actively in Garrard County, it would drive the bid levels down even further on the single-bid projects. The multi-bid projects averaged 26.52 percent below the engineer's estimate. However, the financial impact on the single-bid contracts was that these bids are \$234,754.32 above the competitive level.

WOODFORD COUNTY

There are a total of eight projects in Woodford County. The total contracted value of these projects is \$4,894,328.40 which averages 7.05 percent below the engineer's estimate. The competitive average for District 7 projects is 22.18 percent below the engineer's estimate (see Table 6.28). A total of four firms won contracts in Woodford County including The Allen Company, ATS Construction, Lexington Quarry, and Mago Construction. The two firms that bid

against each other on projects were Lexington Quarry and Mago Construction. Four of the projects were single-bid projects and averaged 0.93 percent above the engineer's estimate. The other five projects had multiple bidders and averaged 15.03 percent below the engineer's estimate. There are many potential bidders that have all of the projects in Woodford County within their 60 mile service area. Of those potential bidders, there are eight who tacitly collude with Mago Construction and refuse to bid in Woodford County including The Allen Company, ATS Construction, Commercial Pavers, H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and Shelbyville Asphalt. In turn Mago Construction is less likely to bid on projects in counties where these firms have projects (see Table 6.31 and Figure 6.35). Lexington Quarry is another bidder and there is they tacitly collude with the other firms by not bidding in their counties (see Figure 6.37). Specifically, they do not bid against H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, and Nally & Gibson Georgetown.

One interesting behavior was that some firms would purchase a bid proposal but not end up bidding on any projects. H.G. Mays, located in Franklin County in District 5, was one of these firms. They purchased bid proposals on two of the nine projects and did not bid on either of them. Both times there were two other firms, Lexington Quarry and Mago Construction, bidding on the projects. ATS Construction did this for one project where Mago Construction was the other bidder, and Lexington Quarry did it for a project where ATS Construction was the other bidder. It is interesting to see how the firms can use the bid proposals to coordinate their bids. What is interesting is that outside of Woodford County, H.G. Mays does not bid in Anderson County. The fact that H.G. Mays does not bid on any projects in Woodford County is a result of their tacit collusion with Mago Construction. In summary, there is evidence that tacit collusion is occurring since firms refuse to bid against Mago Construction and vice versa. Not all of the single-bid contracts are by Mago Construction. However if these firms would actively bid on projects in Woodford County it would result in lower bid levels. Currently the single-bid contracts are \$939,697.50 above the competitive level.

COUNTIES WITH ASPHALT PLANTS

ANDERSON AND MERCER COUNTIES

There are a total of 13 projects in Anderson and Mercer Counties. Mago Construction has an asphalt plant in both counties. The total contracted value of these projects is \$3,914,338.41 which averages 0.22 percent below the engineer's estimate. The competitive average for District 7 projects is 22.18 percent below the engineer's estimate (see Table 6.28). There is only one project in Mercer County where Lincoln County Ready Mix bid on the project. Mago Construction is the primary firm that bids on all of the projects.

In Anderson County, only Mago Construction bid on the six projects that average 2.69 percent above the engineer's estimate. H.G. Mays has an asphalt plant in Franklin County (District 5) and is a firm that could reasonably bid on a project. Other firms that are potential competitors include The Allen Company, ATS Construction, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Nally & Gibson Georgetown, Nally & Haydon Surfacing (District 4), Commercial Pavers (District 5), Flynn Brothers (District 5), Ohio Valley Asphalt (District 5), and Shelbyville Asphalt (District 5). Of those firms there is evidence of tacit collusion between Mago Construction and The Allen Company, ATS Construction, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Nally & Gibson Georgetown, Nally & Haydon Surfacing (District 4), Commercial Pavers (District 5), H.G. Mays (District 5), and Shelbyville Asphalt (District 5). They refrain from bidding against Mago Construction in counties like Anderson County where Mago Construction has their asphalt plants and Mago Construction returns the favor (see Table 6.31). The result of this lack of bidding by these two firms is that bid levels average \$502,941.88 above the competitive level.

In Mercer County, there are 7 projects and they average 2.72 percent below the engineer's estimate. Lincoln County Ready Mix bid on one project in Mercer County, while The Allen Company who also has a plant in Boyle County did not bid on any projects. Like Anderson County, firms who avoid bidding against Mago Construction in Anderson County also do the same in Mercer County with the addition of Elmo Greer & Sons (District 8 and 11) and subtraction of Commercial Pavers (District 5). Flynn Brothers and Ohio Valley Asphalt also could not reasonably bid on projects in Mercer County. The result of this lack of bidding by these firms is that bid levels are \$475,631.27 above the competitive level.

BOURBON COUNTY

There are a total of seven projects in Bourbon County. The total contracted value of these projects is \$2,022,283.40. There is only one bidder, Hinkle Contracting, on all seven projects. The projects' contracted value averages 0.97 percent above the engineer's estimate. The competitive average for all of District 7 projects is 22.18 percent below the engineer's estimate (see Table 6.28).

The firms that can reasonably bid on projects in Bourbon County and show signs of tacitly colluding with Hinkle Contracting in Bourbon County include The Allen Company, ATS Construction, Lexington Quarry, H.G. Mays, Mago Construction, Nally & Gibson Georgetown, and The Walker Company. These firms avoid bidding in each other's counties. Since ATS Construction only bid on one project outside of Fayette County, the additional regression results do not tell the whole story. ATS Construction bids on projects in Fayette County that are within the 11 to 20 mile ring but does not bid on projects in Bourbon County in the same ring. Hinkle Contracting does not bid on projects in Fayette County even though some of the projects are less than 10 miles from their asphalt plant (see Table 6.30). There is strong evidence that these firms are tacitly colluding with each other (see Figure 6.35 and Figure 6.36). The same analysis applies with Hinkle Contracting and The Walker Company. Hinkle Contracting avoids bidding on projects in counties where The Walker Company has asphalt plants, and in turn The Walker Company does not bid on projects in Bourbon County (see Figure 6.36, Figure 6.41, and Table 6.31).

There is strong evidence that tacit collusion is occurring between Hinkle Contracting and The Allen Company, ATS Construction, H.G. Mays, Lexington Quarry, Mago Construction, and Nally & Gibson Georgetown, and The Walker Company. This coordination of bids among these eight firms results in bid levels that are \$468,158.61 above the competitive level.

BOYLE AND MADISON COUNTIES

In Boyle and Madison Counties, The Allen Company has their three plants. Lincoln County Ready Mix also has their only asphalt plant in Boyle County. There are 22 projects in these two counties. The contracted value of these projects is \$7,134,183.63 which averages 12.00 percent below the engineer's estimate. Eleven of these projects are single-bid projects

and average 0.82 percent below the engineer's estimate. Each county will be looked at to see if there is evidence of tacit collusion.

The Allen Company and Lincoln County Ready Mix are the only firms that bid on the 10 projects in Boyle County. Only two of the projects are single-bidder contracts and these projects average 0.93 percent below the engineer's estimate, while the other eight bids average 25.71 percent below the engineer's estimate. It is clear that the competition between The Allen Company and Lincoln County Ready Mix puts downward pressure on bid levels. Mago Construction who is in Mercer County does not bid on projects in Boyle County. Nally & Haydon Surfacing could also reasonably bid in Boyle County but they also do not. Other potential competitors include Hinkle Contracting, Nally & Gibson Georgetown, H.G. Mays (District 5), and Elmo Greer & Sons (District 8 and 11). There is evidence of tacit collusion between Lincoln County Ready Mix and Mago Construction, Nally & Gibson Georgetown, and Nally & Haydon Surfacing. There is evidence that The Allen Company is tacitly colluding with Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, H.G. Mays (District 5) and Elmo Greer & Sons (District 8 and 11). See Table 6.31 for the additional regressions for these firms. This tacit collusion does not have a great impact on bid levels due to the already competitive environment. However, if these firms would have bid against these firms on the two single-bid projects it could have decreased the bid level by about \$159,834.51 compared to the competitive level for District 7.

In Madison County, The Allen Company has two asphalt plants at the north and south ends of the county. There are a total of 12 projects in Madison County with three of them having multiple bids and the other nine only bid on by The Allen Company. The three bids with more than one bidder averages 16.44 percent below the engineer's estimate while the nine single-bid contracts only averages 0.80 percent below the engineer's estimate. Lincoln County Ready Mix bids on three of the projects in Madison County.

The firms that are within reasonable distances to bid on all projects in Madison County are Lincoln County Ready Mix, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, The Walker Company, and Elmo Greer & Sons (District 8 and 11). The firms that avoid bidding in Madison County against The Allen Company include Elmo Greer & Sons, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company and in turn The Allen Company does not bid against these firms (see Table 6.31 and Figure 6.41). The

result of this tacit collusion is that single-bid contracts are \$787,789.45 higher than the competitive level.

FAYETTE COUNTY

In Fayette County, ATS Construction has two asphalt plants. There are a total of 24 projects with a contracted value of \$42,453,380.30. Amazingly each bid only has one bidder. The contracted value of these 24 projects averages 6.34 percent above the engineer's estimate. ATS Construction and Lexington Quarry are the only firms that bid and win projects in Fayette County. They never bid against each other due to the fact that they are owned by the same family. What is amazing is that firms outside of Fayette County never bid on projects including Hinkle Contracting and Nally & Gibson Georgetown who have plants that neighbor Fayette County. These other firms behave like ATS Construction and The Allen Company who can coordinate bids since they are owned by the same family. The other potential competitors that avoid bidding against ATS Construction include Lincoln County Ready Mix, Mago Construction, The Walker Company, H.G. Mays (District 5), Shelbyville Asphalt (District 5), and Elmo Greer & Sons (District 8 and 11). However, according to Table 6.31, ATS Construction is only less likely to bid against projects where Lexington Quarry has an asphalt plant. However, looking at Figure 6.35 it is clear that ATS Construction avoids bidding on projects in these other firms' counties. As discussed earlier, the results indicate in Table 6.30 that the bid proposal variables are driving the results with the county variables not being significant which results in multicollinearity with the county variables. If the bid proposal variables are removed from the regression, the county variables are very significant.

Since there are known problems with the regression, the map for ATS Construction indicates that there is tacit collusion occurring between ATS Construction and other firms. Looking at the maps and regressions for the firms, the following firms avoid bidding against ATS Construction in Fayette County. These firms include H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, and The Walker Company (see Table 6.31 and Figure 6.41). Elmo Greer & Sons and Shelbyville Asphalt have Fayette County at the very edge of their service areas, and are not likely to be strong competitors for ATS Construction. Looking at Hinkle Contracting's map in Figure 6.36, there are projects within 10 miles of their plant, but because it is across the border in Fayette County they do not bid on the project. Nally & Gibson Georgetown in Scott County could also reasonably bid on projects in

Fayette County (see Figure 6.40). Some of the projects in Fayette County are less than 10 miles from their plant. In turn ATS Construction does not bid outside of Fayette County in any of the counties where these firms have their asphalt plants. While the analysis is different for Fayette County than other counties, there is clear evidence of tacit collusion. The result of this tacit collusion is that single-bid contracts are \$12,107,704.06 higher than the competitive level.

JESSAMINE COUNTIES

In Jessamine County, Lexington Quarry has an asphalt plant. There are eight projects with a contracted value of \$4,061,922.20. The eight projects average 3.76 percent above the engineer's estimate and Lexington Quarry is the only firm that bids on the projects. Looking at the additional regression results, for Lexington Quarry in Table 6.30 they treat every county like Jessamine County where they have their asphalt plant. Like ATS Construction, the main factor driving these results is the bid proposal variables resulting in multicollinearity with the county variables. Because of this, I must rely on the map for Lexington Quarry to determine if they are engaging in tacit collusion like I did for ATS Construction in Fayette County. The potential competitors that avoid bidding against Lexington Quarry in Jessamine County include Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, The Walker Company, H.G. Mays (District 5), and Elmo Greer & Sons (District 8 and 11).

Of these firms, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, and Nally & Gibson Georgetown are within a reasonable distance and are less likely to bid against Lexington Quarry in Jessamine County. In turn, Lexington Quarry does not bid on projects in the counties where these firms have asphalt plants even though they reasonably could (see Figure 6.37). There is evidence of tacit collusion between these firms. The result of this tacit collusion is that single-bid contracts are \$1,053,662.62 higher than the competitive level.

MONTGOMERY COUNTY

Montgomery County is located on the eastern edge of District 7. The Walker Company has an asphalt plant in Montgomery County and bids on all seven projects in the county. The contracted value of these seven projects is \$2,146,662.70. These projects average 4.68 percent above the engineer's estimate. The potential competitors for projects in Montgomery County include The Allen Company, ATS Construction, Lexington Quarry, Hinkle Contracting, Nally &

Gibson Georgetown, Eaton Asphalt Paving (District 9), H.G. Mays (District 9), and Mountain Enterprises (District 9). Of these firms, The Allen Company, ATS Construction, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, and Mountain Enterprises are within reasonable a reasonable distance and avoid bidding on projects in Montgomery County where The Walker Company has an asphalt plant (see Table 6.31 and Figure 6.35). These firms avoid bidding on projects in Montgomery County. However, like ATS Construction and Lexington Quarry the bid proposal variables are driving the regression results. Therefore, looking at the map for The Walker Company it is clear that they avoid bidding on projects where these firms have asphalt plants (see Figure 6.41). The exception is that they do bid in Powell County where Hinkle Contracting has an asphalt plant. However, they do avoid bidding in Bourbon County. So the evidence of tacit collusion between The Walker Company and Hinkle Contracting is not as strong, but there is still evidence. The result of this tacit collusion is that single-bid contracts are \$576,593.60 higher than the competitive level.

SCOTT COUNTY

Nally & Gibson Georgetown has an asphalt plant in Scott County. There are a total of 11 projects and all are single-bid projects bid on only by Nally & Gibson Georgetown. These 11 projects average 1.42 percent above the engineer's estimate. The firms that could reasonably bid on projects in Scott County are less likely to according to the additional regressions. These firms include The Allen Company, ATS Construction, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Mago Construction, H.G. Mays (District 5), Shelbyville Asphalt (District 5), Barrett Paving (District 6), and Eaton Asphalt Paving (District 6). Since Nally & Gibson only bids in Scotty County the results reflects this occurrence and they avoid bidding against these other firms. These firms do not bid in Scott County and Nally & Gibson Georgetown, in turn, does not bid in those counties. The result is that contracted bids average \$1,133,910.05 above the competitive level.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 7 is high levels of tacit collusion. There are multiple firms that could bid on projects but do not because they are located in someone else's county. ATS Construction, Lexington Quarry, and The Walker Company all have regressions that suffer from multicollinearity between the county variables

and the bid proposal variables. This results in the county variables not giving reliable results. This is due primarily to the firms bidding mainly in their own counties. The maps of these three firms were used in the analysis instead to determine if they were engaging in tacit collusion with the other firms. The general results from District 7 are that firms primarily stick to their own county and do not bid on projects in adjacent county. The result is that in all 12 counties there is evidence of tacit collusion between firms. The financial impact of this is that the tacit collusion results in bids that are \$19,378,600.55 above the competitive level. Around \$12 million of this comes from Fayette County where ATS Construction is the lone bidder and no other competitors bid against them.

Table 6.28: Summary of Tacit Collusion for District 7 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Clark				12	\$ 4,360,402.95	-0.67	Yes	Seven Firms (A)	\$ 937,922.67
Garrard	6	\$ 1,554,897.00	-26.52	3	\$ 905,338.70	3.75	Yes	Nine Firms (B)	\$ 234,754.32
Woodford	4	\$ 828,134.10	-15.03	4	\$ 4,066,194.30	0.93	Yes	Ten Firms (C)	\$ 939,697.50
TOTAL (WITHOUT ASPHALT PLANTS)	10	\$ 2,383,031.10	-21.93	19	\$ 9,331,935.95	0.36			
WITH ASPHALT PLANTS									
Anderson				6	\$ 1,444,930.05	2.69	Yes	Eleven Firms (D)	\$ 502,941.88
Bourbon				7	\$ 2,022,283.40	0.97	Yes	Eight Firms (E)	\$ 468,158.61
Boyle	8	\$ 2,158,160.38	-25.71	2	\$ 752,162.40	-0.93	Yes	Eight Firms (F)	\$ 159,834.51
Fayette				24	\$42,453,380.30	6.34	Yes	Seven Firms (G)	\$ 12,107,704.06
Jessamine				8	\$ 4,061,922.20	3.76	Yes	Seven Firms (H)	\$ 1,053,662.62
Madison	3	\$ 539,158.10	-16.44	9	\$ 3,684,702.75	-0.80	Yes	Six Firms (I)	\$ 787,789.45
Mercer	1	\$ 234,299.00	-13.66	6	\$ 2,235,109.36	-0.90	Yes	Eleven Firms (J)	\$ 475,631.27
Montgomery				7	\$ 2,146,662.70	4.68	Yes	Seven Firms (K)	\$ 576,593.60
Scott				11	\$ 4,804,703.60	1.42	Yes	Eleven Firms (L)	\$ 1,133,910.05
TOTAL (WITH ASPHALT PLANTS)	12	\$ 2,931,617.48	-22.39	80	\$63,605,856.76	2.99			
TOTAL (DISTRICT 7)	22	\$ 5,314,648.58	-22.18	99	\$72,937,792.71	2.49			\$ 19,378,600.55

(A) These firms include The Allen Company, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company

(B) These firms include The Allen Company, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and The Walker Company

(C) These firms include The Allen Company, ATS Construction, Commercial Pavers, H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and Shelbyville Asphalt

(D) These firms include The Allen Company, ATS Construction, Commercial Pavers, H.G. Mays, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and Shelbyville Asphalt

(E) These firms include The Allen Company, ATS Construction, H.G. Mays, Hinkle Contracting, Lexington Quarry, Mago Construction, and The Walker Company

(F) These firms include The Allen Company, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, and Nally & Haydon Surfacing

(G) These firms include ATS Construction, H.G. Mays, Hinkle Contracting, Mago Construction, Lincoln County Ready Mix, Nally & Gibson Georgetown, and The Walker Company

(H) These firms include Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lexington Quarry, Mago Construction, Lincoln County Ready Mix, and Nally & Gibson Georgetown

(I) These firms include The Allen Company, Elmo Greer & Sons, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company

(J) These firms include The Allen Company, ATS Construction, Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, Nally & Haydon Surfacing, and Shelbyville Asphalt

(K) These firms include The Allen Company, ATS Construction, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Mountain Enterprise, and The Walker Company

(L) These firms include The Allen Company, ATS Construction, Barrett Paving, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Mago Construction, Nally & Gibson Georgetown, and Shelbyville Asphalt

Table 6.29: Summary Statistics for District 7 Firms

VARIABLES	The Allen Company		ATS Construction		Hinkle Contracting		Lexington Quarry	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.161	0.368	0.0742	0.263	0.202	0.402	0.0711	0.258
Distance Variables								
Distance (0 to 10 miles) [reference variable]	0.0536	0.226	0.0742	0.263	0.0810	0.273	0.100	0.301
Distance (11 to 20 miles)	0.188	0.391	0.148	0.356	0.169	0.376	0.0502	0.219
Distance (21 to 30 miles)	0.155	0.362	0.113	0.317	0.169	0.376	0.172	0.378
Distance (31 to 40 miles)	0.182	0.386	0.177	0.382	0.224	0.417	0.176	0.381
Distance (41 to 50 miles)	0.193	0.396	0.212	0.409	0.188	0.391	0.201	0.401
Distance (51 to 60 miles)	0.229	0.421	0.276	0.448	0.168	0.374	0.301	0.46
Other Control Variables								
Jobs Under Contract	5.060	1.865	2.516	1.447	10.01	2.944	1.322	0.856
Engineer's Estimate	549,472	1.37E+06	487,538	1.38E+06	526,064	1.32E+06	500,855	1.48E+06
Competitive Variables								
Number of Competitor Service Areas	10.24	2.926	11.17	2.325	8	3.767	11.72	1.963
Zero other competitive bid proposal purchased [reference variable]	0.0744	0.263	0.0636	0.244	0.177	0.382	0.0460	0.21
One other competitive bid proposal purchased	0.682	0.467	0.562	0.497	0.512	0.5	0.640	0.481
Two other competitive bid proposals purchased	0.188	0.391	0.276	0.448	0.267	0.443	0.243	0.43
Three or more other competitive bid proposals purchased	0.0565	0.231	0.0989	0.299	0.0433	0.204	0.0711	0.258
County Variables								
Project in same county-no rival	0.0357	0.186	0.0848	0.279	0.136	0.343	0.0335	0.18
Project in same county-rival	0.0298	0.17	0	-	0	-	0	-
Project in adjacent county-no rival [reference variable]	0.259	0.439	0.251	0.434	0.294	0.456	0.272	0.446
Project in adjacent county-rival	0.676	0.469	0.664	0.473	0.571	0.495	0.695	0.462
Observations	336		283		531		239	

Table 6.29 (continued)

VARIABLES	Lincoln County Ready Mix		Mago Construction		Nally & Gibson Georgetown		The Walker Company	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.122	0.328	0.179	0.384	0.0407	0.198	0.0898	0.286
Distance Variables								
Distance (0 to 10 miles) [reference variable]	0.0349	0.184	0.0684	0.253	0.0222	0.148	0.0367	0.188
Distance (11 to 20 miles)	0.0655	0.248	0.219	0.414	0.122	0.328	0.0857	0.281
Distance (21 to 30 miles)	0.148	0.356	0.281	0.45	0.148	0.356	0.127	0.333
Distance (31 to 40 miles)	0.249	0.433	0.167	0.373	0.144	0.352	0.245	0.431
Distance (41 to 50 miles)	0.245	0.431	0.132	0.338	0.215	0.411	0.237	0.426
Distance (51 to 60 miles)	0.258	0.438	0.133	0.34	0.348	0.477	0.269	0.445
Other Control Variables								
Jobs Under Contract	0.148	0.368	6.147	2.196	0.396	0.697	4.176	2.969
Engineer's Estimate	624,509	1.62E+06	638,763	1.62E+06	479,711	1.41E+06	548,297	1.65E+06
Competitive Variables								
Number of Competitor Service Areas	11.28	2.381	8.968	3.021	11.20	2.215	9.351	3.538
Zero other competitive bid proposal purchased [reference variable]	0	-	0.0544	0.227	0.0407	0.198	0.0776	0.268
One other competitive bid proposal purchased	0.773	0.42	0.446	0.497	0.504	0.501	0.710	0.455
Two other competitive bid proposals purchased	0.157	0.365	0.302	0.459	0.281	0.451	0.180	0.385
Three or more other competitive bid proposals purchased	0.0699	0.255	0.198	0.399	0.174	0.38	0.0327	0.178
County Variables								
Project in same county-no rival	0	-	0.128	0.334	0.0407	0.198	0.0531	0.225
Project in same county-rival	0.0437	0.205	0.0105	0.102	0	-	0	-
Project in adjacent county-no rival [reference variable]	0.236	0.425	0.277	0.448	0.252	0.435	0.310	0.464
Project in adjacent county-rival	0.721	0.45	0.584	0.493	0.707	0.456	0.637	0.482
Observations	229		570		270		245	

Table 6.30: Regression results for District 7 firms

VARIABLES	The Allen Company		ATS Construction		Hinkle Contracting		Lexington Quarry	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.237*** (0.0894)	-0.0399 (0.0490)	-0.204 (0.139)	0.00597 (0.00761)	0.0177 (0.0352)	0.117*** (0.0447)	0.0511 (0.143)	0.0244 (0.129)
Distance (21 to 30 miles)	-0.605*** (0.0952)	-0.277*** (0.0646)	-0.246* (0.145)	-0.0205 (0.0231)	-0.0850** (0.0401)	0.0781* (0.0432)	-0.103 (0.0988)	-0.106 (0.0826)
Distance (31 to 40 miles)	-0.673*** (0.0919)	-0.391*** (0.0628)	-0.242* (0.145)	-0.0171 (0.0205)	-0.0904** (0.0448)	0.0721 (0.0441)	-0.154 (0.0935)	-0.153** (0.0772)
Distance (41 to 50 miles)	-0.668*** (0.0918)	-0.382*** (0.0628)	-0.243* (0.147)	-0.0153 (0.0168)	-0.108** (0.0465)	0.0517 (0.0432)	-0.152 (0.0948)	-0.150* (0.0774)
Distance (51 to 60 miles)	-0.673*** (0.0933)	-0.397*** (0.0637)	-0.242 (0.148)	-0.0134 (0.0146)	-0.124*** (0.0475)	0.0399 (0.0431)	-0.148 (0.0957)	-0.127* (0.0742)
Jobs Under Contract	-0.0133** (0.00652)	-0.00840 (0.00517)	-0.00445 (0.00313)	-0.00372 (0.00250)	-0.00162 (0.00210)	-0.00149 (0.00187)	0.00423 (0.0127)	0.00452 (0.0101)
Engineer's Estimate	1.65e-08*** (4.16e-09)	1.11e-08** (3.30e-09)	2.13e-09 (5.31e-09)	3.01e-09 (4.65e-09)	6.13e-09*** (2.21e-09)	-5.43e-09* (2.80e-09)	-1.03e-08 (7.22e-09)	-8.35e-09 (6.53e-09)
Potential Competitors	-0.00785*** (0.00284)	-0.00918*** (0.00277)	0.000764 (0.00196)	0.00162 (0.00196)	-0.00408** (0.00176)	-0.00166 (0.00144)	0.00427 (0.00428)	0.00924* (0.00484)
One competitive bid proposal purchased	-0.503*** (0.0692)	-0.399*** (0.0664)	-0.786*** (0.128)	-0.664*** (0.196)	-0.881*** (0.0365)	-0.725*** (0.0591)	-0.853*** (0.0901)	-0.715*** (0.171)
Two competitive bid proposals purchased	-0.551*** (0.0732)	-0.444*** (0.0656)	-0.790*** (0.128)	-0.669*** (0.197)	-0.906*** (0.0325)	-0.754*** (0.0555)	-0.820*** (0.0907)	-0.697*** (0.171)
Three or more competitive bid proposals purchased	-0.477*** (0.0728)	-0.342*** (0.0766)	-0.793*** (0.127)	-0.671*** (0.196)	-0.888*** (0.0373)	-0.739*** (0.0585)	-0.846*** (0.0916)	-0.704*** (0.172)
Project in same county-rival		0.241** (0.0959)						
Project in adjacent county-no rival		-0.177*** (0.0637)		-0.300 (0.198)		-0.277*** (0.0693)		-0.177 (0.195)
Project in adjacent county-rival		-0.424*** (0.0671)		-0.314 (0.196)		-0.356*** (0.0769)		-0.254 (0.192)
Constant	1.334*** (0.0808)	1.289*** (0.0724)	1.033*** (0.0489)	0.983*** (0.0286)	1.059*** (0.0390)	1.057*** (0.0329)	0.943*** (0.0651)	0.975*** (0.107)
Observations	336	336	283	283	531	531	239	239
R-squared	0.662	0.788	0.874	0.883	0.864	0.892	0.674	0.702

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.30 (continued)

VARIABLES	Lincoln County Ready Mix		Mago Construction		Nally & Gibson Georgetown		The Walker Company	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.0248 (0.215)	0.125 (0.214)	-0.454*** (0.0581)	-0.249*** (0.0635)	0 (0)	0 (0)	0.0343 (0.0286)	-0.00492 (0.00558)
Distance (21 to 30 miles)	-0.313* (0.189)	0.0139 (0.249)	-0.727*** (0.0514)	-0.425*** (0.0716)	0 (0)	-0 (0)	-0.0856 (0.0600)	-0.153 (0.0926)
Distance (31 to 40 miles)	-0.565*** (0.175)	-0.175 (0.244)	-0.829*** (0.0478)	-0.505*** (0.0724)	0 (0)	-0 (0)	-0.0733 (0.0667)	-0.152 (0.105)
Distance (41 to 50 miles)	-0.637*** (0.173)	-0.263 (0.242)	-0.862*** (0.0479)	-0.515*** (0.0742)	0 (0)	-0 (0)	-0.0924 (0.0642)	-0.162 (0.0985)
Distance (51 to 60 miles)	-0.641*** (0.173)	-0.285 (0.242)	-0.889*** (0.0491)	-0.545*** (0.0763)	0 (0)	-0 (0)	-0.0924 (0.0643)	-0.163 (0.0992)
Jobs Under Contract	-0.0585* (0.0337)	-0.0842** (0.0345)	0.00350 (0.00440)	0.00231 (0.00360)	0 (0)	0* (0)	0.00140 (0.00260)	0.00147 (0.00261)
Engineer's Estimate	-1.48e-09 (3.05e-09)	-6.64e-10 (3.91e-09)	-4.65e-10 (3.30e-09)	2.63e-09 (2.38e-09)	0*** (0)	-0** (0)	-2.01e-09 (1.88e-09)	-2.05e-09 (1.93e-09)
Potential Competitors	-0.0156*** (0.00556)	-0.0118** (0.00471)	-0.0188*** (0.00492)	-0.0114*** (0.00415)	-0** (0)	0*** (0)	-0.00157 (0.00108)	-0.00207 (0.00126)
One competitive bid proposal purchased	-0.0251* (0.0149)	-0.0347 (0.0232)	-0.470*** (0.0552)	-0.189*** (0.0620)	-1*** (0)	-0*** (0)	-0.907*** (0.0644)	-0.950*** (0.0464)
Two competitive bid proposals purchased	-0.0538 (0.0351)	-0.0900** (0.0437)	-0.510*** (0.0574)	-0.214*** (0.0679)	-1*** (0)	-0*** (0)	-0.909*** (0.0639)	-0.937*** (0.0520)
Three or more competitive bid proposals purchased			-0.632*** (0.0572)	-0.273*** (0.0709)	-1*** (0)	0 (0)	-0.906*** (0.0647)	-0.941*** (0.0505)
Project in same county-rival				0.182** (0.0715)				
Project in adjacent county-no rival		-0.330* (0.183)		-0.380*** (0.0842)		-1*** (0)		0.0786 (0.0561)
Project in adjacent county-rival		-0.540*** (0.187)		-0.527*** (0.0793)		-1*** (0)		0.124 (0.0785)
Constant	0.845*** (0.189)	0.947*** (0.190)	1.488*** (0.0811)	1.278*** (0.0735)	1*** (0)	1*** (0)	1.009*** (0.00789)	1.014*** (0.0105)
Observations	229	229	570	570	270	270	245	245
R-squared	0.376	0.473	0.577	0.692	1.000	1.000	0.864	0.869

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-rival"

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.31: Additional regression results for District 7 firms and firms outside District 7

VARIABLES	The Allen Company			ATS Construction			Hinkle Contracting			Lexington Quarry		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)									
Project in adjacent county-no rival	-0.177*** (0.0637)	-0.142** (0.0576)		-0.300 (0.198)	-0.290 (0.204)		-0.277*** (0.0693)	-0.244*** (0.0650)		-0.177 (0.195)	0.0911 (0.259)	
Project in adjacent county-rival	-0.424*** (0.0671)		-1*** (0)	-0.314 (0.196)	-0.332* (0.198)		-0.356*** (0.0769)	-0.683*** (0.111)		-0.254 (0.192)		-0.283 (0.195)
Project in adjacent county-Allen Company					-0.311 (0.201)			-0.341*** (0.0759)			0.0637 (0.259)	
Project in adjacent county-ATS Construction		-0.678*** (0.0720)						-0.391*** (0.0843)			-0.278 (0.198)	
Project in adjacent county-Barrett Paving		-0.251*** (0.0778)			-0.287 (0.203)			-0.262*** (0.0667)			0.0483 (0.260)	
Project in adjacent county-Bluegrass Paving					-0.0129 (0.00795)			0.0248 (0.0657)				
Project in adjacent county-Commercial Pavers												
Project in adjacent county-Eaton Asphalt Paving								-0.0134 (0.0633)				
Project in adjacent county-Elmo Greer & Sons		-0.463*** (0.0766)			-0.284 (0.204)			-0.316*** (0.0715)			0.0814 (0.258)	
Project in adjacent county-Flynn Brothers												
Project in adjacent county-HG Mays		-0.244*** (0.0645)			-0.308 (0.201)			-0.318*** (0.0726)			0.00508 (0.265)	
Project in adjacent county-Hinkle Contracting		-0.385*** (0.0683)			-0.299 (0.203)						0.0761 (0.259)	
Project in adjacent county-Lexington Quarry		-0.445*** (0.0693)			-0.339* (0.201)			-0.328*** (0.0749)				
Project in adjacent county-Lincoln County Ready Mix					0.0143 (0.0153)			0.0488* (0.0251)			-0.0451 (0.0456)	
Project in adjacent county-Mago Construction		-0.331*** (0.0765)			-0.306 (0.202)			-0.300*** (0.0706)			0.0270 (0.261)	
Project in adjacent county-Mountain Enterprises								-0.331*** (0.0742)				
Project in adjacent county-Nally & Gibson Georgetown		-0.247*** (0.0651)			-0.331* (0.200)			-0.354*** (0.0791)			0.00107 (0.267)	
Project in adjacent county-Nally & Haydon		-0.307*** (0.0640)			-0.321 (0.200)			-0.282*** (0.0697)			0.0317 (0.264)	
Project in adjacent county-Ohio Valley Asphalt					-0.299 (0.202)							
Project in adjacent county-Shelbyville Asphalt		-0.227*** (0.0787)			-0.301 (0.204)			-0.236*** (0.0679)			0.0370 (0.264)	
Project in adjacent county-Walker Company		-0.392*** (0.0685)			-0.293 (0.202)			-0.395*** (0.0832)			0.0810 (0.255)	
Project in Clark County			-0** (0)		-0.331* (0.198)			-0.702*** (0.107)				-0.298 (0.196)
Project in Garrard County			-0*** (0)		-0.325 (0.199)			-0.674*** (0.113)				-0.294 (0.197)
Project in Woodford County			-1*** (0)		-0.193 (0.237)			-0.658*** (0.116)				0.418* (0.246)
Constant	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)	0.983*** (0.0286)	0.955*** (0.0549)	1.005*** (0.0150)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	0.975*** (0.107)	0.936*** (0.163)	1.133*** (0.0930)
Observations	336	336	336	283	283	283	531	531	531	239	239	239
R-squared	0.788	0.834	1.000	0.883	0.884	0.888	0.892	0.893	0.942	0.702	0.739	0.852

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.31 (continued)

VARIABLES	Lincoln County Ready Mix			Mago Construction			Nally & Gibson Georgetown			The Walker Company		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival				0.182**	0.143*	0.423***						
				(0.0715)	(0.0767)	(0.0733)						
Project in adjacent county-no rival	-0.330*	-0.341*		-0.380***	-0.296***		-1***	0*		0.0786	0.0776	
	(0.183)	(0.185)		(0.0842)	(0.0842)		(0)	(0)		(0.0561)	(0.0580)	
Project in adjacent county-rival	-0.540***		-0.739***	-0.527***	-0.364***		-1***	0***		0.124		0.00635
	(0.187)		(0.224)	(0.0793)	(0.0605)		(0)	(0)		(0.0785)		(0.00713)
Project in adjacent county-Allen Company		-0.284		-0.314***			0*			0.101		
		(0.226)		(0.0822)			(0)			(0.0748)		
Project in adjacent county-ATS Construction		-0.503***		-0.427***			0**			0.0850		
		(0.190)		(0.0827)			(0)			(0.0859)		
Project in adjacent county-Barrett Paving				-0.449***			0*			0.0635		
				(0.100)			(0)			(0.0623)		
Project in adjacent county-Bluegrass Paving				0.316***			-0					
				(0.101)			(0)					
Project in adjacent county-Commercial Pavers				-0.699***			0					
				(0.0842)			(0)					
Project in adjacent county-Eaton Asphalt Paving				-0.308***			0			-0.00610		
				(0.0825)			(0)			(0.0268)		
Project in adjacent county-Elmo Greer & Sons		-0.547***		-0.357***			0			0.0928		
		(0.188)		(0.0823)			(0)			(0.0659)		
Project in adjacent county-Flynn Brothers							0					
							(0)					
Project in adjacent county-HG Mays		-0.387*		-0.383***			0*			0.0856		
		(0.200)		(0.0790)			(0)			(0.0752)		
Project in adjacent county-Hinkle Contracting		-0.570***		-0.384***			0*			0.167*		
		(0.190)		(0.0808)			(0)			(0.0981)		
Project in adjacent county-Lexington Quarry		-0.809***		-0.479***			0*			0.110		
		(0.204)		(0.0857)			(0)			(0.0743)		
Project in adjacent county-Lincoln County Ready Mix				-0.381***			0***					
				(0.0650)			(0)					
Project in adjacent county-Mago Construction		-0.540***					0*			0.0825		
		(0.194)					(0)			(0.0626)		
Project in adjacent county-Mountain Enterprises							0			0.108		
							(0)			(0.0709)		
Project in adjacent county-Nally & Gibson Georgetown		-0.398**		-0.361***			0			0.102		
		(0.195)		(0.0849)			(0)			(0.0716)		
Project in adjacent county-Nally & Haydon		-0.652***		-0.448***			0*					
		(0.197)		(0.0829)			(0)					
Project in adjacent county-Ohio Valley Asphalt				-0.475***			0*					
				(0.0853)			(0)					
Project in adjacent county-Shelbyville Asphalt		-0.442**		-0.524***			0*					
		(0.194)		(0.0943)			(0)					
Project in adjacent county-Walker Company				-0.298***			0*					
				(0.0845)			(0)					
Project in Clark County			-0.728***			-0.375***		0***			-0.303*	
			(0.225)			(0.0651)		(0)			(0.165)	
Project in Garrard County			-0.126			-0.360***		0***			0.0107	
			(0.226)			(0.0633)		(0)			(0.0131)	
Project in Woodford County			-0.765***			0.127		0***			0.0111	
			(0.231)			(0.182)		(0)			(0.0150)	
Constant	0.947***	1.042***	0.859***	1.278***	1.264***	1.227***	1***	1***	1***	1.014***	0.975***	1.005***
	(0.190)	(0.228)	(0.190)	(0.0735)	(0.0818)	(0.0737)	(0)	(0)	(0)	(0.0105)	(0.0227)	(0.00721)
Observations	229	229	229	570	570	570	270	270	270	245	245	245
R-squared	0.473	0.538	0.668	0.692	0.710	0.773	1.000	1.000	1.000	0.869	0.874	0.888

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.31 (continued)

VARIABLES	Nally & Haydon Surfacing (District 4)			Commercial Pavers (District 5)			Flynn Brothers (District 5)			HG Mays (District 5 & 9)			Ohio Valley Asphalt (District 5)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival										0.128 (0.0996)	0.252** (0.117)	0.218* (0.111)			
Project in adjacent county-no rival	-0.288** (0.111)	-0.0603 (0.0698)		-0.764*** (0.116)	-0.737*** (0.107)		-0.0619 (0.407)	-0.115 (0.386)		-0.653*** (0.133)	-0.408*** (0.144)		-0.520*** (0.105)	-0.00685 (0.116)	
Project in adjacent county-rival	-0.371*** (0.110)	-1*** (0)		-0.754*** (0.109)	-0.760*** (0.112)		0.00133 (0.406)	0.00249 (0.410)		-0.729*** (0.133)	-0.374*** (0.128)		-0.638*** (0.0949)	-0.229*** (0.0679)	
Project in adjacent county-Allen Company		-0.0718 (0.0553)			-0.751*** (0.119)			-0.166 (0.390)			-0.406*** (0.148)				
Project in adjacent county-ATS Construction		-0.0783 (0.0522)			-0.715*** (0.119)						-0.546*** (0.155)		0.0446 (0.123)		
Project in adjacent county-Barrett Paving											-0.466*** (0.144)		-0.0668 (0.120)		
Project in adjacent county-Bluegrass Paving											0.458*** (0.148)		0.267 (0.180)		
Project in adjacent county-Commercial Pavers		-0.0495 (0.0615)									-0.433*** (0.146)		-0.522*** (0.0979)		
Project in adjacent county-Eaton Asphalt Paving					-0.761*** (0.113)						-0.450*** (0.145)		-0.392** (0.181)		
Project in adjacent county-Elmo Greer & Sons															
Project in adjacent county-Flynn Brothers															
Project in adjacent county-HG Mays		-0.100* (0.0525)			-0.784*** (0.113)			-0.0168 (0.390)						-0.00697 (0.129)	
Project in adjacent county-Hinkle Contracting		-0.102 (0.0620)									-0.541*** (0.141)				
Project in adjacent county-Lexington Quarry		-0.112* (0.0580)			-0.728*** (0.116)						-0.499*** (0.148)				
Project in adjacent county-Lincoln County Ready Mix		-0.129** (0.0588)									0.0325 (0.0300)				
Project in adjacent county-Mago Construction		-0.163*** (0.0551)			-0.784*** (0.103)			-0.0554 (0.386)			-0.420*** (0.151)		0.0730 (0.122)		
Project in adjacent county-Mountain Enterprises											-0.525*** (0.137)				
Project in adjacent county-Nally & Gibson Georgetown					-0.741*** (0.122)						-0.538*** (0.156)		0.0525 (0.120)		
Project in adjacent county-Nally & Haydon					-0.763*** (0.104)			-0.0283 (0.387)			-0.360** (0.155)		0.0619 (0.122)		
Project in adjacent county-Ohio Valley Asphalt		-0.0525 (0.0581)			-0.839*** (0.0983)			0.0502 (0.386)			-0.450*** (0.144)				
Project in adjacent county-Shelbyville Asphalt		-0.0709 (0.0560)			-0.255 (0.156)			-0.0552 (0.404)			-0.396** (0.179)		-0.189 (0.124)		
Project in adjacent county-Walker Company											-0.516*** (0.141)				
Project in Clark County												-0.362*** (0.130)			
Project in Garrard County			-1*** (0)									-0.329** (0.133)			
Project in Woodford County			-1*** (0)		-0.854*** (0.133)			-0.0474 (0.420)			-0.586*** (0.123)			-0.156 (0.100)	
Constant	1.048*** (0.0468)	1.037*** (0.0846)	1*** (0)	0.890*** (0.0841)	0.927*** (0.0953)	0.850*** (0.104)	0.605*** (0.150)	0.560*** (0.166)	0.598*** (0.168)	1.210*** (0.0723)	1.306*** (0.0974)	1.119*** (0.0535)	1.294*** (0.107)	1.367*** (0.0911)	1.241*** (0.133)
Observations	291	291	291	202	202	202	165	165	165	373	373	373	231	231	231
R-squared	0.862	0.853	1.000	0.663	0.716	0.665	0.435	0.445	0.436	0.667	0.665	0.764	0.665	0.727	0.640

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.31 (continued)

VARIABLES	Shelbyville Asphalt (District 5)			Barrett Paving (District 6)			Bluegrass Paving (District 6)			Eaton Asphalt Paving (District 6)			Elmo Greer & Sons (District 8 & 11)			Mountain Enterprises (District 9)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival				-0.0460 (0.0377)	-0.0894** (0.0412)	0.0267 (0.0330)				-0.109* (0.0656)	-0.145** (0.0656)	-0.0173 (0.0277)	0 (0)	-0 (0)	0.00677 (0.00842)	0.0151 (0.0481)	0.0163 (0.0450)	0.0116 (0.0205)
Project in adjacent county-no rival	-0.831*** (0.147)	-0.413*** (0.125)		-0.276*** (0.0736)	-0.334*** (0.0727)		-0.0974 (0.134)	-0.0758 (0.139)		-0.300*** (0.0877)	-0.431*** (0.0902)		-1*** (0)	-1*** (0)		-0.0994*** (0.0333)	-0.0742** (0.0344)	
Project in adjacent county-rival	-0.836*** (0.146)		-0.836*** (0.148)	-0.380*** (0.104)	-0.863*** (0.0782)		-0.173 (0.146)	-0.248 (0.202)		-0.310*** (0.0878)	-0.346*** (0.0880)		-1*** (0)		-0.922*** (0.0752)	-0.418*** (0.0525)		-0.819*** (0.0627)
Project in adjacent county-Allen Company		-0.423*** (0.124)											-1*** (0)					
Project in adjacent county-ATS Construction		-0.419*** (0.118)			-0.352*** (0.0790)					-0.462*** (0.0806)			-1*** (0)					
Project in adjacent county-Barrett Paving		-0.409*** (0.125)						-0.216 (0.176)			-0.0267 (0.0675)							
Project in adjacent county-Bluegrass Paving																		
Project in adjacent county-Commercial Pavers		-0.308** (0.127)																
Project in adjacent county-Eaton Asphalt Paving		-0.396*** (0.133)			-0.193 (0.246)			-0.328 (0.207)									0.108 (0.0689)	
Project in adjacent county-Elmo Greer & Sons																	-0.416*** (0.0586)	
Project in adjacent county-Flynn Brothers																		
Project in adjacent county-HG Mays		-0.420*** (0.120)			-0.289** (0.116)			0.0848 (0.173)			-0.533*** (0.116)						-0.331*** (0.0773)	
Project in adjacent county-Hinkle Contracting		-0.427*** (0.119)			-0.401*** (0.0788)						-0.650*** (0.111)		-1*** (0)				-0.464*** (0.0536)	
Project in adjacent county-Lexington Quarry		-0.423*** (0.119)											-1*** (0)					
Project in adjacent county-Lincoln County Ready Mix													-0*** (0)					
Project in adjacent county-Mago Construction		-0.358*** (0.118)			-0.550*** (0.101)			-0.146 (0.144)			-0.405*** (0.119)		-1*** (0)				-0.191** (0.0743)	
Project in adjacent county-Mountain Enterprises											-0.658*** (0.133)		-1*** (0)					
Project in adjacent county-Nally & Gibson Georgetown		-0.432*** (0.119)			-0.364*** (0.0819)			-0.0972 (0.155)			-0.412*** (0.0782)							
Project in adjacent county-Nally & Haydon		-0.429*** (0.119)											-1*** (0)					
Project in adjacent county-Ohio Valley Asphalt		-0.425*** (0.133)			-0.520*** (0.0979)			-0.0726 (0.146)			-0.737*** (0.113)							
Project in adjacent county-Shelbyville Asphalt					-0.305*** (0.101)						-0.482*** (0.0981)							
Project in adjacent county-Walker Company											-0.577*** (0.101)		-1*** (0)				-0.223*** (0.0561)	
Project in Clark County											-0.347*** (0.0905)				-0.922*** (0.0755)			-0.842*** (0.0581)
Project in Garrard County															-0.919*** (0.0783)			
Project in Woodford County			-0.834*** (0.143)												-0.934*** (0.0645)			
Constant	-0.0875 (0.0973)	-0.0782 (0.180)	-0.0907 (0.109)	1.179*** (0.0644)	1.317*** (0.101)	1.023*** (0.0476)	0.640*** (0.166)	0.635*** (0.177)	0.583*** (0.143)	1.180*** (0.108)	1.309*** (0.120)	1.096*** (0.0972)	1*** (0)	1*** (0)	0.992*** (0.00895)	1.108*** (0.0373)	1.144*** (0.0383)	1.049*** (0.0214)
Observations	214	214	214	182	182	182	135	135	135	244	244	244	277	277	277	279	279	279
R-squared	0.695	0.453	0.695	0.841	0.863	0.900	0.547	0.555	0.553	0.572	0.666	0.642	1.000	1.000	0.983	0.878	0.886	0.967

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.33: District 7

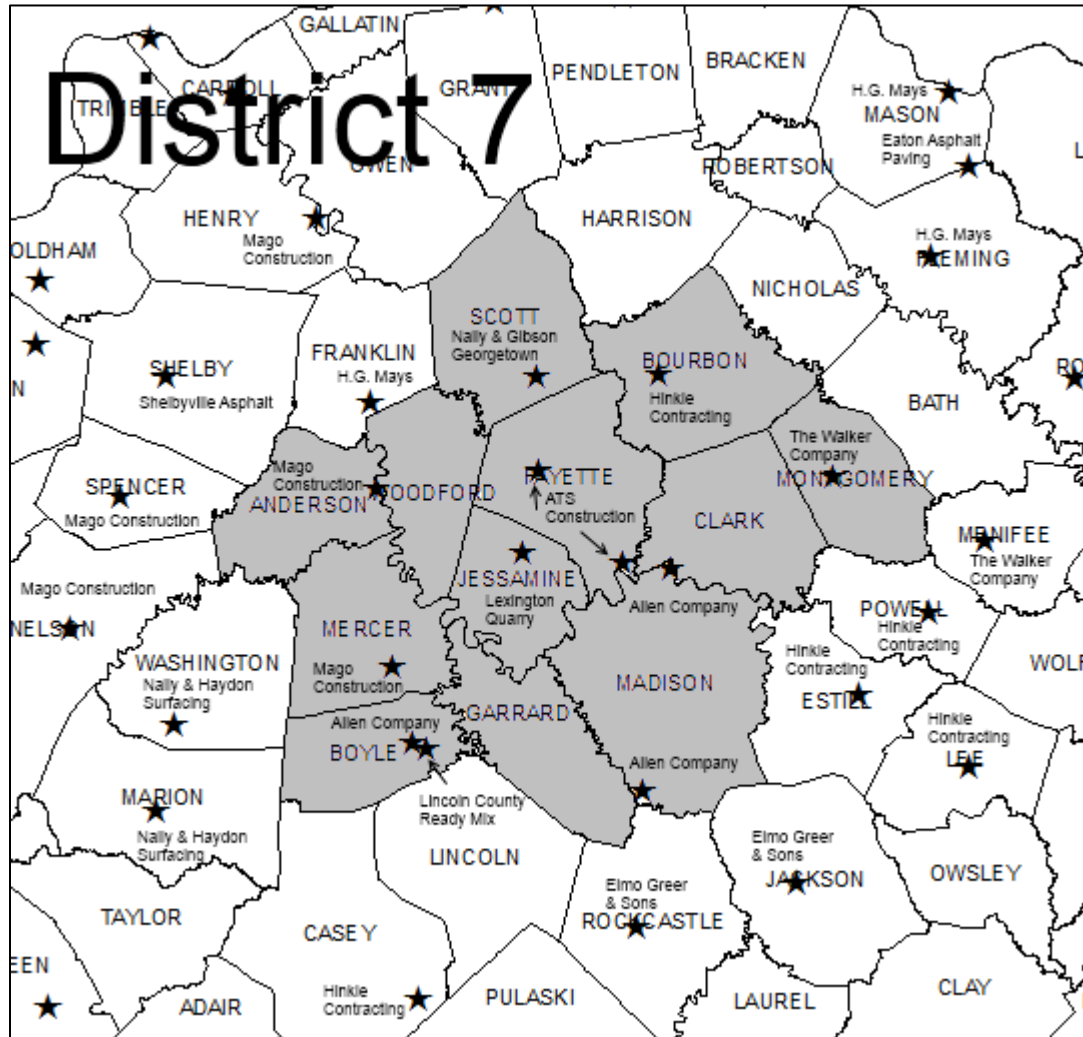


Figure 6.34: The Allen Company Service Area

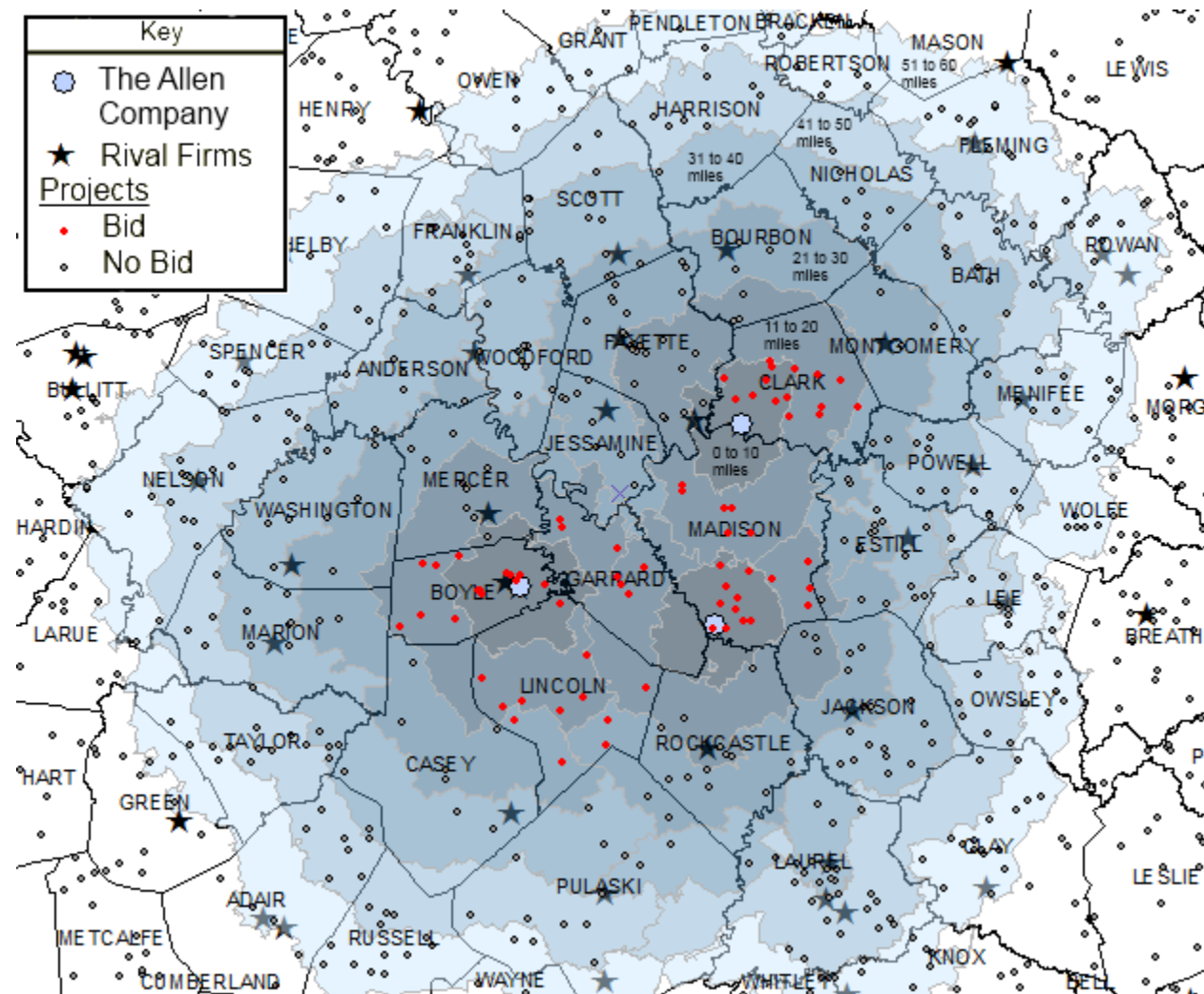


Figure 6.35: ATS Construction Service Area

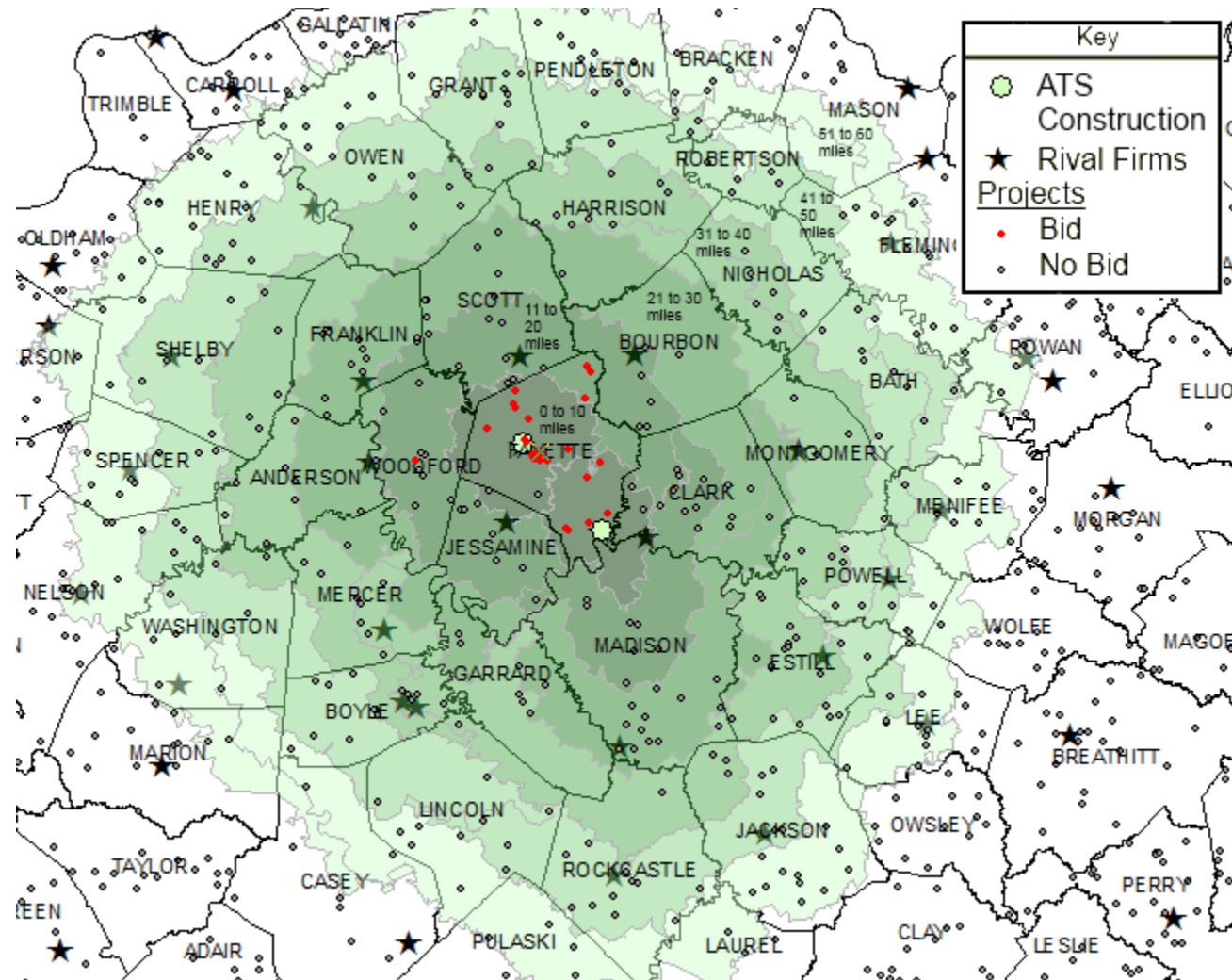


Figure 6.36: Hinkle Contracting Service Area

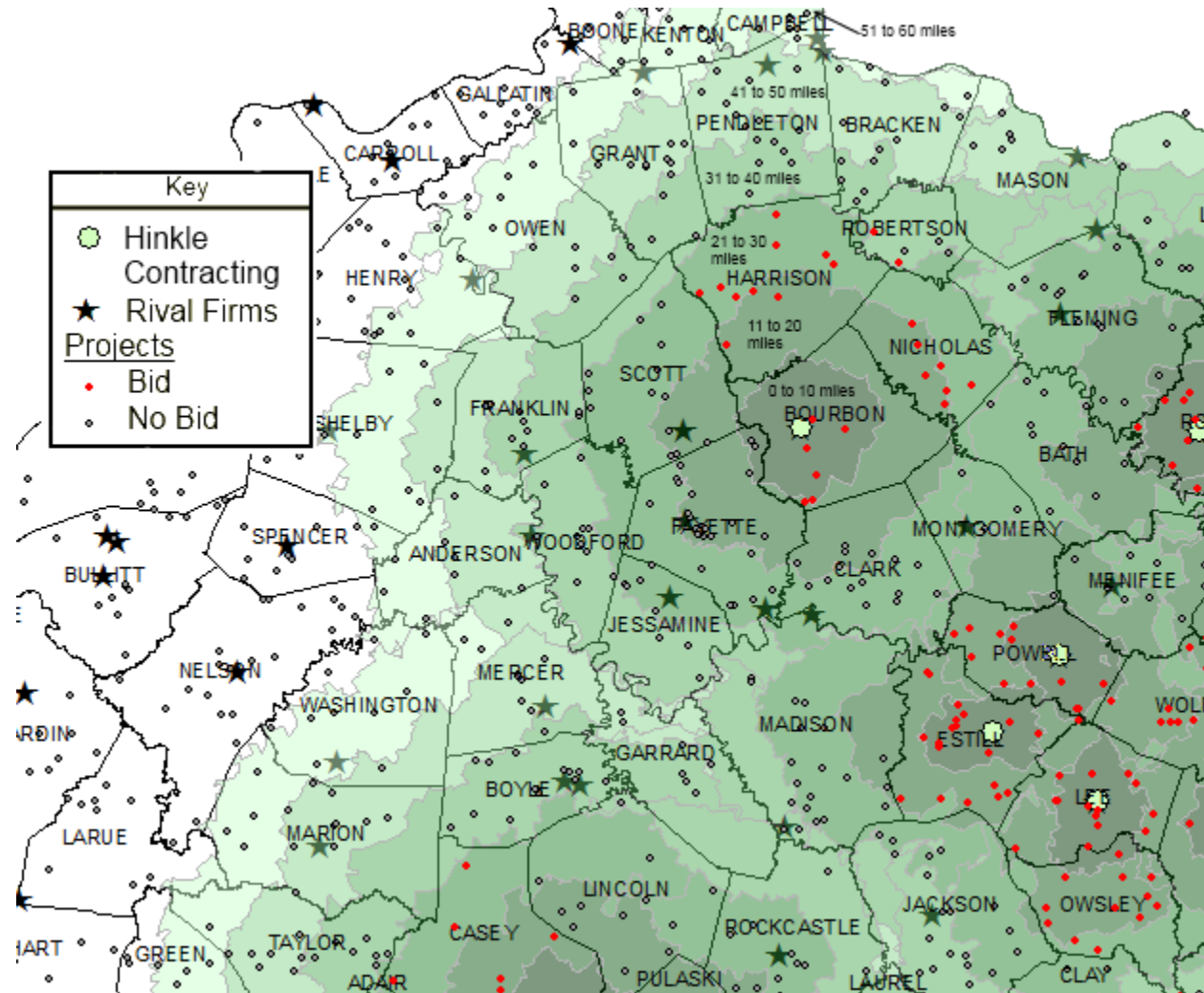


Figure 6.37: Lexington Quarry Service Area

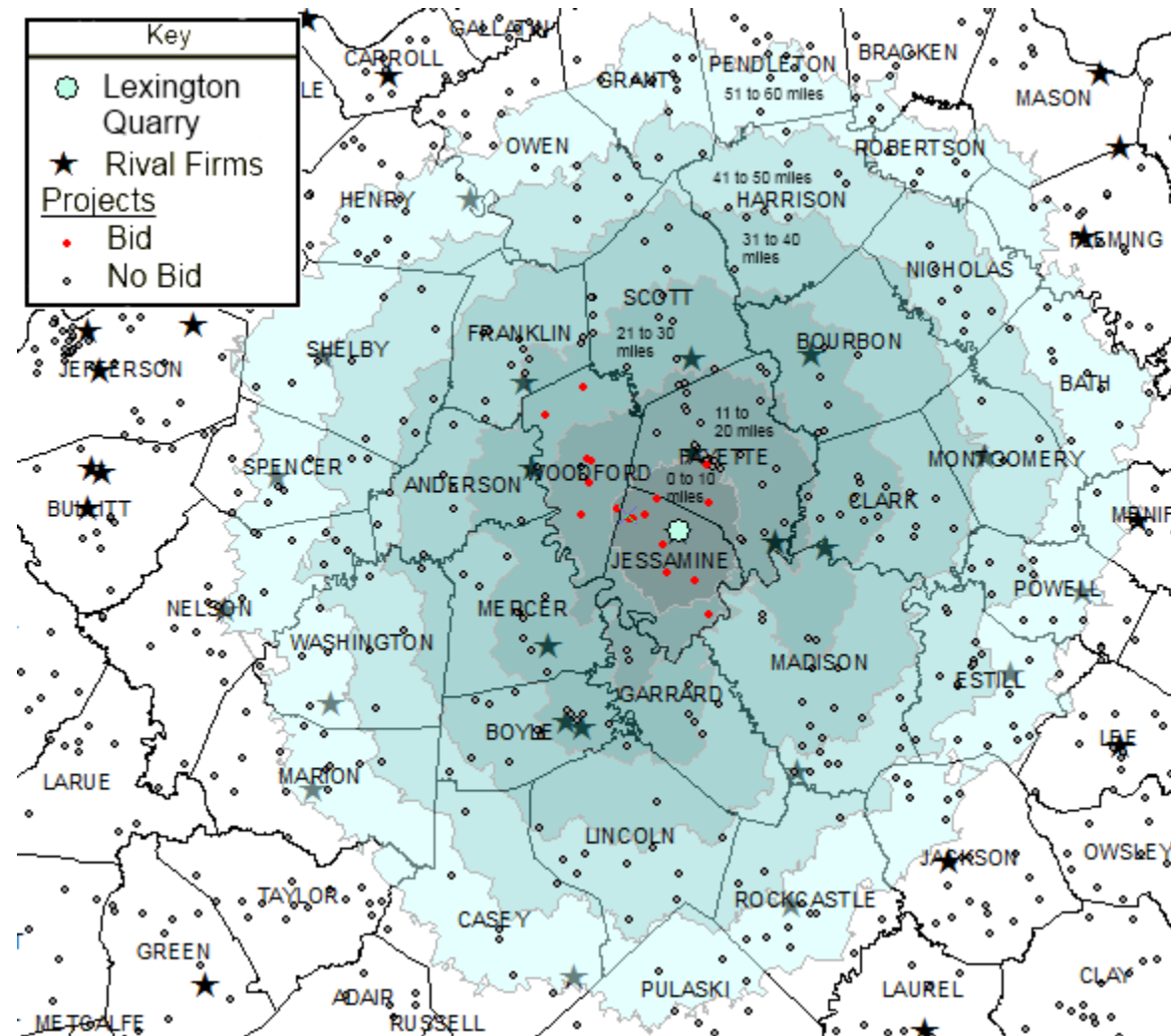
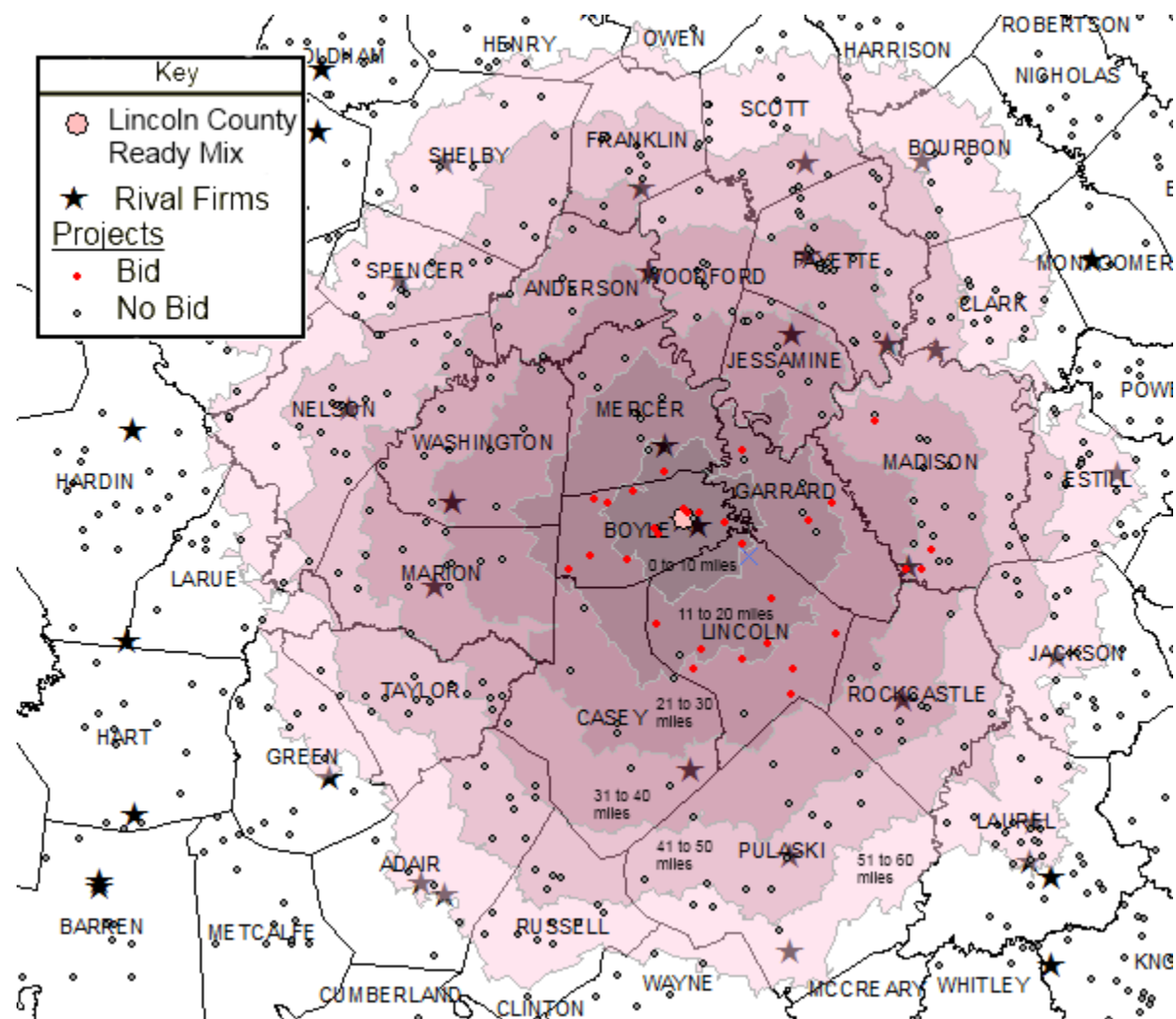


Figure 6.38: Lincoln County Ready Mix Service Area



275

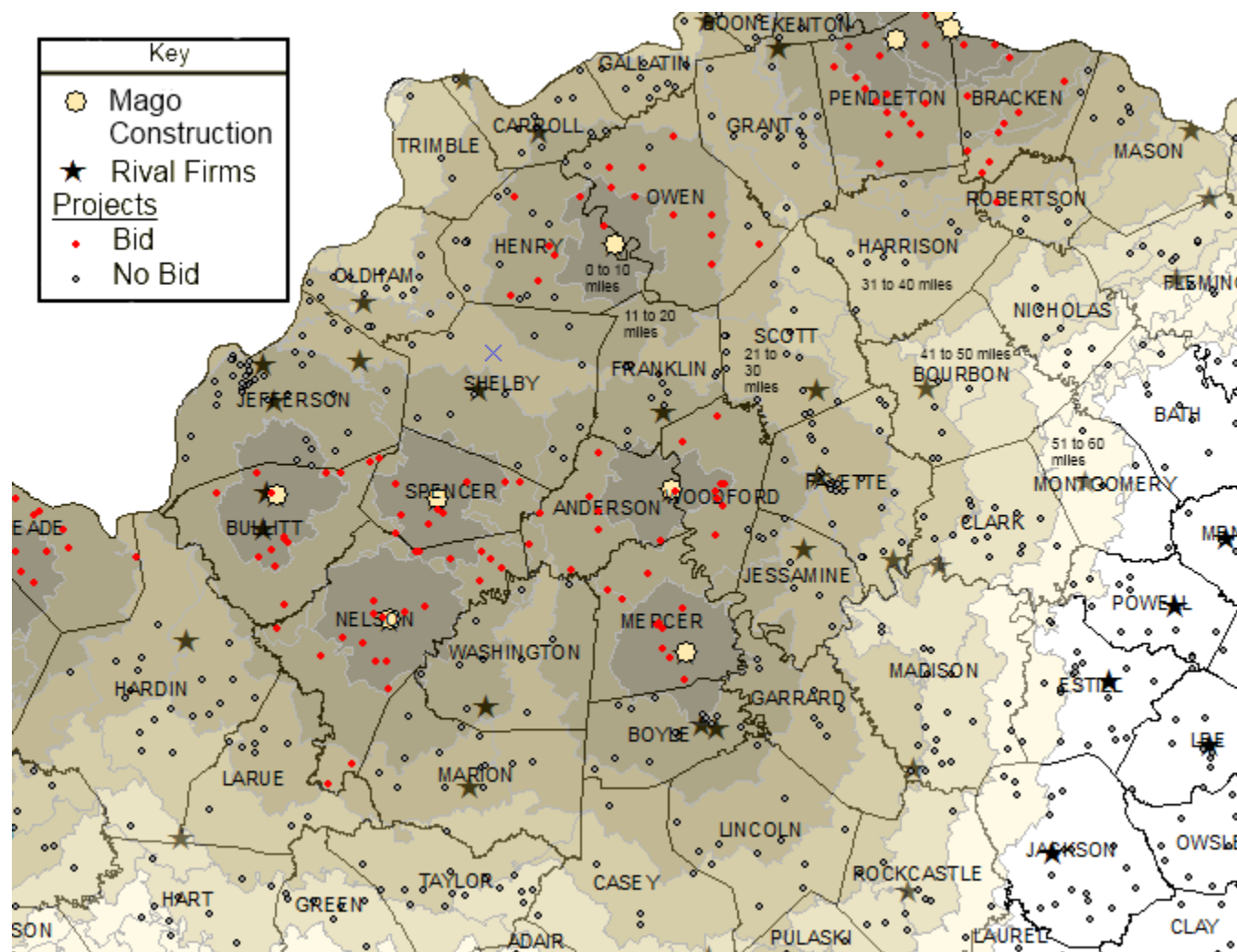


Figure 6.40: Nally & Gibson Georgetown Service Area

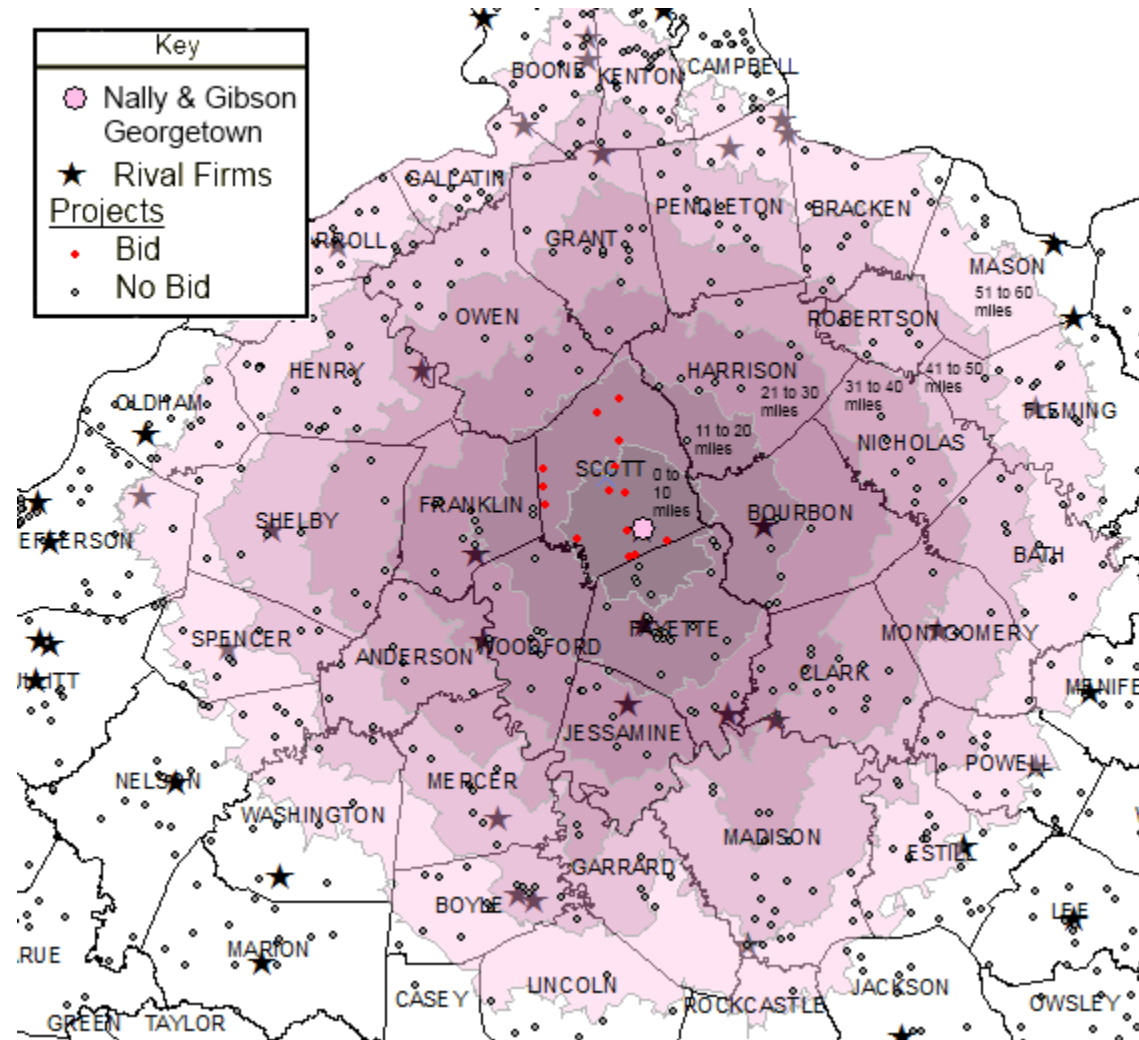
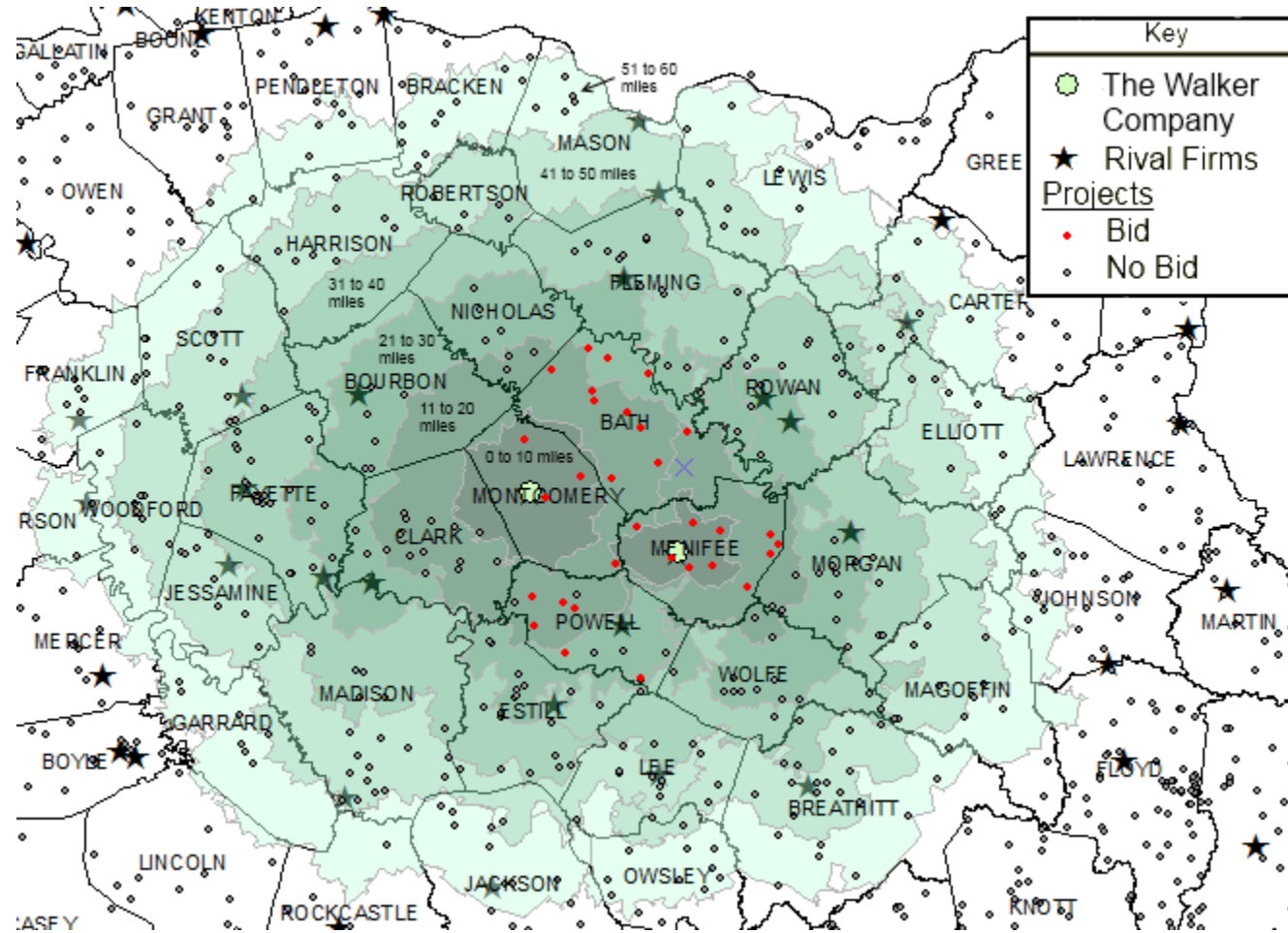


Figure 6.41: The Walker Company Service Area



6.9 District 8 – Southern Kentucky

District 8 consists of firms in south-central Kentucky near the Tennessee border (see Figure 6.42). There are four firms that have plants located in this district and that compete on projects: Gaddie-Shamrock, Elmo Greer & Sons, Hinkle Contracting, and Mago Construction. Other firms outside District 8 that bid or could reasonably bid on projects include The Allen Company, ATS Construction, Glass Paving, Kay & Kay Contracting, Lexington Quarry, Lincoln County Ready Mix, Nally & Haydon Surfacing, and Scotty's Contracting. There is evidence of tacit collusion in all counties. This will be explained in more detail later in this section. The pattern that emerges is that bid in their own counties where they have asphalt plants and do not bid in rival firm's counties. There is abundant evidence that firms are coordinating bids with each other. The result of this tacit collusion is that there are single-bid contracts which increase bids \$9,060,636.59 above the competitive level.

The contracted value of the projects in District 8 average 4.76 percent below the engineer's estimate, which is just below the Kentucky average of 3.84 percent below the engineer's estimate. An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.32, Table 6.33, Table 6.34, and Table 6.35. A map for the firms with asphalt plants in the district follows the tables. The additional regression results found in Table 6.35 include all of the control variables, but only the variation on the county variables are displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.9.1 Firms with Asphalt Plants in District 8

ELMO GREER & SONS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Elmo Greer & Sons has one of their 10 plants located in District 8. Their primary competitors in this district are The Allen Company (District 7), Lincoln County Ready Mix (District 7) and Hinkle Contracting. They bid on 69 projects in Kentucky and eight of them are in Rockcastle County in District 8. They were awarded all eight projects. The contracted value of the eight projects was \$2,728,397.63. The average number of bidders on these projects was 1.5 bidders. There are four single-bid contracts where Elmo Greer & Sons was the only bidder. The

four single-bid projects average 2.90 percent above the engineer's estimate while the five projects with more than one bidder average 18.67 percent below the engineer's estimate. Kay and Kay Contracting started bidding regularly in 2006. They are the firm that bid aggressively against Elmo Greer & Sons in Rockcastle County. Clearly competition puts downward pressure on bid levels.

FIRM BID FUNCTION

The bid function for Elmo Greer & Sons can be found in Table 6.34. Without county variables, it indicates that once a project gets beyond 10 miles, the probability of Elmo Greer & Sons bidding diminishes significantly. However, when the county variables are added the distance variables are not significant. This also happens with every other variable. They are all significant, but when the county variables are added they do not have a significant level of explanatory power. The reason is that the variables for "Project in adjacent county" are highly significant in explaining why Elmo Greer & Sons bids on a project. Both of the adjacent county variables are significant and negative and perfectly explain Elmo Greer & Sons bidding behavior. This illustrates the fact that they stick to bidding in the counties where they have asphalt plants and do not bid beyond their county boundaries (see Figure 6.43). In the additional regressions in Table 6.35, specific firm and county variables were added. They are less likely to bid against The Allen Company, ATS Construction, Gaddie-Shamrock, Hinkle Contracting, Lexington Quarry, Mago Construction, and Nally & Haydon Surfacing. They are also less likely to bid on projects in Lincoln County which is next door to Rockcastle County, McCreary County which is next to Whitley County in District 11 where Elmo Greer & Sons has asphalt plants, and Russell County. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the "Counties" section.

GADDIE-SHAMROCK

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Gaddie-Shamrock has three asphalt plants, with two of those plants located in Adair County and one plant located in Clinton County. Their primary competitors in this district are Hinkle Contracting and Mago Construction. They also border one county where Nally & Haydon Surfacing (District 4) has an asphalt plant and receives competition from Burton Paving. Gaddie-Shamrock bid on 29 projects in Kentucky and all of them are in District 8 counties. They were

awarded 28 of the 29 projects. Burton Paving won one of the projects. The contracted value of all of the 29 projects was \$26,531,783.71. The average number of bidders on these projects was 1.21 bidders. There were 23 single-bid contracts that average 1.73 percent above the engineer's estimate. The other six projects average 15.95 percent below the engineer's estimate. Their bid function will be discussed in the next section.

FIRM BID FUNCTION

The bid function for Gaddie-Shamrock is in Table 6.34. Without and with the county variables, it indicates that once a project gets beyond 20 miles, the probability of Gaddie-Shamrock bidding on a project diminishes significantly. The bid proposal variables are negative and significant at the 10 percent level and this becomes more distinct when the county variables are added. The "Project in adjacent county-rival" is negative and significant. This means they are less likely to bid on a project that is in a county where their rival firm has an asphalt plant than a project in Adair or Clinton Counties. In Table 6.35 specific firm and county variables were added to this regression. They are less likely to bid on projects in counties where Mago Construction (Wayne) and Nally & Haydon Surfacing (Green) have asphalt plants. They are also less likely to bid on projects in Lincoln and McCreary Counties. More of their bidding behavior will be explored in the "Counties" section.

HINKLE CONTRACTING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Hinkle Contracting has three of their 11 asphalt plants located in Casey and Pulaski Counties in District 8. Their primary competitors in this district are Elmo Greer & Sons, Gaddie-Shamrock, and Mago Construction. The Allen Company, Kay & Kay Contracting, Lincoln County Ready Mix, and Nally & Haydon Surfacing have plants in counties that border District 8. They bid on 107 projects in Kentucky and 19 of those projects are located in District 8 in Casey, McCreary and Pulaski Counties. They were awarded all 19 projects. The contracted value of all of the 19 projects was \$10,463,445.35. The average number of bidders on these projects was 1.11 bidders. There were 17 single-bid contracts that average 1.29 percent above the engineer's estimate. The remaining two bids have two bidders and average 7.54 percent below the engineer's estimate. The factors that influence their bidding on projects will be explored in the next section.

FIRM BID FUNCTION

The bid function for The Hinkle Contracting is in Table 6.34. The bid function for Hinkle Contracting was described in detail in District 7. Only the interesting points will be highlighted here. When the county variables are added, the distance variables are no longer negative and significant. The adjacent county variables are negative and significant. This means they are less likely to bid on a project in an adjacent county where a rival firm has an asphalt plant. Specific firms and counties were added to the regression in Table 6.35. They are less likely to bid on projects in counties where The Allen Company, ATS Construction, Elmo Greer & Sons, Gaddie-Shamrock, Lexington Quarry, Mago Construction, and Nally & Haydon Surfacing have asphalt plants. They are also less likely to bid on projects in Cumberland, Lincoln, and Russell Counties. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the “Counties” section.

MAGO CONSTRUCTION

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mago Construction has one of their 12 plants located in District 8. The primary competitors in District 8 for Mago Construction are Elmo Greer & Sons, Gaddie-Shamrock, and Hinkle Contracting. They bid on 102 projects in Kentucky and six of those are in counties in District 8. They were awarded all six of the contracts. The contracted value of the six projects was \$3,254,020.20. The average number of bidders on these projects was 1.00 bidders. The contracted value of these six single-bid contracts averaged 5.17 percent above the engineer’s estimate. Whether or not Mago Construction is tacitly colluding in District 8 will be analyzed in the “Counties” section.

FIRM BID FUNCTION

The results of the bid function for Mago Construction were discussed in detail in the District 4 section. The important points of the bid function will be highlighted here. Distance, competitor behavior, and which county a project is located in all significantly influence whether or not Mago Construction bids on a project. The county variables indicate that Mago Construction is less likely to bid on a project in a county adjacent to where they have their asphalt plant. They avoid bidding in counties where The Allen Company, ATS Construction, Elmo Greer & Sons, Gaddie-Shamrock, Glass Paving, Hinkle Contracting, Lexington Quarry, Lincoln

County Ready Mix, Nally & Haydon Surfacing, and Scotty's Contracting have asphalt plants. They are also less likely to bid on projects in Cumberland, Lincoln, and Russell Counties in District 8. More of their bidding behavior will be explored in the "Counties" section.

6.9.2 Counties in District 8

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.35). The additional regressions for firms outside District 8 will be discussed and included in Table 6.35. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.34). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

CUMBERLAND COUNTY

There are a total of eight projects in Cumberland County. The total contracted value of these projects is \$4,496,450.86. Seven of the eight projects only had one bidder, Gaddie-Shamrock, and average 1.20 percent above the engineer's estimate. The average for competitive bids for District 8 projects is 20.80 percent below the engineer's estimate (see Table 6.32). The other firm that bids on one project in Cumberland County is Burton Paving, though they never bid against Gaddie-Shamrock again.¹²⁶ The other potential competitors include Mago Construction, Glass Paving (District 3), Scotty's Contracting (District 3), and Nally & Haydon Surfacing (District 4). The additional regression for these firms shows that these four firms are less likely to bid on projects in Cumberland County after controlling for distance and the other factors. In turn Gaddie-Shamrock is less likely to bid against Mago Construction and Nally & Haydon Surfacing. There is no evidence of tacit collusion between Gaddie-Shamrock and Glass Paving and Scotty's Contracting (see Table 6.35). If you look at the Gaddie-Shamrock map in

¹²⁶ Burton Paving was acquired by Gaddie-Shamrock after this bid.

Figure 6.44, Gaddie-Shamrock only bids in four counties. There is evidence of tacit collusion between Gaddie-Shamrock and Mago Construction and Nally & Haydon Surfacing. This coordination of bid results in bid levels that are \$941,331.53 above the competitive level for District 8.

LINCOLN COUNTY

There are a total of 11 projects in Lincoln County. The total contracted value of these projects is \$3,580,035.35 which averages 22.07 percent below the engineer's estimate. The average for competitive District 8 projects is 20.80 percent below the engineer's estimate (see Table 6.32). All but one of the projects has two or more bidders. The Allen Company and Lincoln County Ready Mix actively bid on projects in Lincoln County. This fierce competition drives bid levels down. However, there are other firms that could bid on projects in Lincoln County including Hinkle Contracting and Elmo Greer & Sons. Other potential bidders include Mago Construction, Nally & Haydon Surfacing (District 4), ATS Construction (District 7), and Lexington Quarry (District 7). A variable for Lincoln County was added to the additional regressions for these firms. All of these firms avoid bidding in Lincoln County when other factors are controlled, and both The Allen Company and Lincoln County Ready Mix avoid bidding in these firm's counties. For Lexington Quarry, it is clear they avoid bidding in Lincoln County from their map (see Figure 6.37). While the fierce competition between The Allen Company and Lincoln County Ready Mix keeps bid levels low, there is still evidence of tacit collusion. This tacit collusion results in bid levels that are \$80,922.76 above the competitive level.

MCCREARY COUNTY

There are a total of three projects in McCreary County. The total contracted value of these projects is \$2,036,770.40, which average 2.36 percent below the engineer's estimate. The average for competitive District 8 projects is 20.80 percent below the engineer's estimate (see Table 6.32). Hinkle Contracting and Mago Construction bid on and won projects in McCreary County. All of the projects have only one bidder which switches between Hinkle Contracting and Mago Construction. The other potential competitors include Elmo Greer & Sons, Gaddie-Shamrock, and Kay & Kay Contracting (District 11). A variable for McCreary County was added to their additional regressions. Only Elmo Greer & Sons and Gaddie-Shamrock avoid bidding on projects in McCreary County (see Table 6.35). In turn both Mago Construction and Hinkle

Contracting avoid bidding in counties where these two firms have asphalt plants. If these two firms bid actively against Mago Construction and Hinkle Contracting it would drive bids down further. This tacit collusion results in bid levels that are \$375,580.46 above the competitive level.

RUSSELL COUNTY

There are a total of seven projects in Russell County. The total contracted value of these projects is \$9,432,096.81, which averages 2.40 percent below the engineer's estimate. The average for competitive District 8 projects is 20.80 percent below the engineer's estimate (see Table 6.32). Six of these projects only have one bidder, Gaddie-Shamrock, and these projects average 0.23 above the engineer's estimate, while the one bid with more than one bidder is 18.15 percent below the engineer's estimate. The other firm that bids is Burton Paving. Both Hinkle Contracting and Mago Construction have plants located in counties next to Russell County. Nally & Haydon Surfacing in District 4 is another potential competitor. In the additional regression for both firms in Table 6.35, the variable for Russell County is negative and significant for Hinkle Contracting, Mago Construction, and Nally & Haydon Surfacing. These firms avoid bidding in Russell County and in turn Gaddie-Shamrock avoids bidding against Nally & Haydon Surfacing and Mago Construction. There is evidence of tacit collusion which increases bid levels by \$1,919,142.00 over the competitive level.

COUNTIES WITH ASPHALT PLANTS

ADAIR AND CLINTON COUNTIES

Gaddie-Shamrock has three asphalt plants located in Adair and Clinton Counties. Burton Paving bids against Gaddie-Shamrock in Adair County, while Gaddie-Shamrock is the only bidder in Clinton County. Nally & Haydon Surfacing (District 4) in Green County could reasonably bid on projects in Adair County. Hinkle Contracting and Mago Construction are competitors that border Clinton County. Glass Paving and Scotty's Contracting from District 3 are also potential competitors. Each county will be analyzed individually in the next two paragraphs.

In Adair County, there are nine projects and Gaddie-Shamrock won the contract for eight of the projects. Burton Paving was the other bidder. Five of the projects only have one bidder, Gaddie-Shamrock, and the contracted value averages 4.14 percent above the engineer's

estimate. The four projects with two bidders average 14.97 percent below the engineer's estimate. The potential bidders include Hinkle Contracting, Glass Paving (District 3), Scotty's Contracting (District 3), and Nally & Haydon Surfacing (District 4). A variable was included in the additional regressions for Gaddie-Shamrock. All of the firms are less likely to bid on projects in counties where Gaddie-Shamrock has their asphalt plants. However, Gaddie-Shamrock only avoids bidding against Nally & Haydon Surfacing. For the other firms, there is some other factor that is driving why they do not bid on projects where those firms have asphalt plants. This tacit collusion leads to the single-bid contracts and bid levels that average \$2,201,267.70 above the competitive level.

There are five projects in Clinton County and Gaddie-Shamrock is the only bidder. There are three other potential competitors include Hinkle Contracting, Mago Construction, and Scotty's Contracting. All three of these firms are less likely to bid on projects where Gaddie-Shamrock has an asphalt plant; however, Gaddie-Shamrock only avoids bidding against Mago Construction in Wayne County. If you look at Figure 6.44 and Figure 6.46 it is clear these firms avoid bidding in the other county. There is evidence of tacit collusion between Gaddie-Shamrock and Mago Construction. This tacit collusion leads to the single-bid contracts and bid levels that average \$539,230.09 above the competitive level.

CASEY AND PULASKI COUNTIES

Hinkle Contracting has three asphalt plants located in Casey and Pulaski Counties. All but two of the 17 projects are single-bid contracts and only bid on by Hinkle Contracting. Kay & Kay Contracting (District 11) is the firm who bid on two projects in Pulaski County. Each county will be analyzed individually in the next two paragraphs.

In Casey County, there are six projects. Hinkle Contracting is the only bidder on all six projects and the contracted value averages 1.50 percent below the engineer's estimate. Lincoln County Ready Mix purchases a bid proposal on one project but never bid on the project. Other potential competitors include Elmo Greer & Sons, Gaddie-Shamrock, Mago Construction, Nally & Haydon Surfacing (District 4), The Allen Company (District 7) and Lincoln County Ready Mix (District 7). The additional regressions for these firms show that Elmo Greer & Sons, Mago Construction, Nally & Haydon Surfacing, and The Allen Company are less likely to bid on projects where Hinkle Contracting has asphalt plants, and in turn Hinkle Contracting is less likely to bid

on projects where these firms bid and have asphalt plants. For example, Hinkle Contracting does not bid on projects in Boyle County, Lincoln County, or Madison County where The Allen Company has asphalt plants and bids. There is evidence tacit collusion is occurring between Hinkle Contracting and Elmo Greer & Sons, Mago Construction, Nally & Haydon Surfacing, and The Allen Company. This tacit collusion leads to the single-bid contracts and bid levels that average \$511,255.52 above the competitive level.

There are 11 projects in Pulaski County. Hinkle Contracting bids on all of the projects and Kay & Kay Contracting bids on two of them. The nine single-bid contracts average 3.93 percent above the engineer's estimate while the two projects with two bidders averages 7.54 percent below the engineer's estimate. While it is clear that Kay & Kay Contracting could and does bid on projects, Elmo Greer & Sons, Gaddie-Shamrock, Mago Construction, The Allen Company (District 7), and Lincoln County Ready Mix (District 7) are other potential firms. Of these firms Elmo Greer & Sons, Mago Construction, and The Allen Company are less likely to bid against Hinkle Contracting, and Hinkle Contracting is less likely to bid against these firms. Mago Construction could reasonably bid on projects in Pulaski County but does not and Hinkle Contracting avoids bidding in Wayne County (see Figure 6.45 and Figure 6.46). Elmo Greer & Sons only bids on projects in counties where they have plants and does not extend out into counties where other firms have asphalt plants. This holds true with Pulaski County. The Allen Company never bids against Hinkle Contracting. The tacit collusion between Hinkle Contracting and the other three firms leads to the single-bid contracts and bid levels that average \$1,375,955.14 above the competitive level.

ROCKCASTLE COUNTY

In Rockcastle County, Elmo Greer & Sons has an asphalt plant. There are eight projects in these counties. The contracted value of these projects is \$2,728,397.63. The main competitor for Elmo Greer & Sons is Kay & Kay Contracting who bid against them on four of the eight projects. This is due to the fact that Kay & Kay Contracting do not start bidding on asphalt projects until mid-2006. The other four projects are only bid on by Elmo Greer & Sons. The single-bid projects average 2.90 percent above the engineer's estimate while the competitive bids average 24.59 percent below the engineer's estimate. Other firms that could bid in Rockcastle County include Gaddie-Shamrock, Hinkle Contracting, Mago Construction, The Allen Company (District 7), ATS Construction (District 7), Lexington Quarry (District 7), and Lincoln

County Ready Mix (District 7). When a variable was added for Elmo Greer & Sons to the additional regressions, The Allen Company, Hinkle Contracting and Mago Construction are all less likely to bid on projects where Elmo Greer & Sons has an asphalt plant. ATS Construction and Lexington Quarry avoid bidding on projects in Rockcastle County (see Figure 6.35 and Figure 6.37). In turn Elmo Greer & Sons is less likely to bid against these firms. Looking at Figure 6.43, Elmo Greer & Sons does not bid outside counties where they have asphalt plants. This coordination of bid results in bid levels that are \$388,884.61 above the competitive level.

WAYNE COUNTY

In Wayne County, Mago Construction has an asphalt plant. There are five projects and the contracted value of these projects is \$2,638,123.30. All of these projects are single-bid projects and average 6.76 percent above the engineer's estimate. The competitive average for District 8 is 20.80 percent below the engineer's estimate. The two firms that could bid on projects in Wayne County are Gaddie-Shamrock in Clinton County and Hinkle Contracting in Pulaski County. The additional regressions show these firms are less likely to bid on projects in counties where Mago Construction has an asphalt plant, and Mago Construction avoids bidding against these firms in Clinton and Pulaski Counties (see Table 6.35 and Figure 6.46). These firms are tacitly colluding by using county boundaries as focal points and not bidding across them into each other's territories. This coordination of bid results in bid levels that are \$727,066.78 above the competitive level.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 8 is very similar to District 7. Firms avoid bidding in counties where rivals either bid or have asphalt plants. This results in a high number of single-bid projects. There is evidence of tacit collusion in every county. When firms bid where there was typically only one bidder, then bid levels were driven down. However, most firms simply refused to bid on projects in a rival's counties and this increased bid levels. Where there is firm evidence of tacit collusion bid levels are \$9,060,636.59 above the competitive bid level for District 8.

Table 6.32: Summary of Tacit Collusion for District 8 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of	Contracted Value of	% Value Over/Under	Number of	Contracted Value	% Value Over/Under	Evidence?	Firms Involved	Financial Impact
	Projects	Projects	Engineer's Estimate	Projects	of Projects	Engineer's Estimate	(Yes or No)		
WITHOUT ASPHALT PLANTS									
Cumberland	1	\$ 217,671.16	-17.64	7	\$ 4,278,779.70	1.20	Yes	Three Firms (A)	\$ 941,331.53
Lincoln	10	\$ 3,274,666.45	-24.84	1	\$ 305,368.90	5.70	Yes	Eight Firms (B)	\$ 80,922.76
McCreary				3	\$ 2,036,770.40	-2.36	Yes	Four Firms (C)	\$ 375,580.46
Russell	1	\$ 306,362.16	-18.15	6	\$ 9,125,734.65	0.23	Yes	Three Firms (D)	\$ 1,919,142.00
TOTAL (WITHOUT ASPHALT PLANTS)	12	\$ 3,798,699.77	-23.69	17	\$15,746,653.65	0.49			
WITH ASPHALT PLANTS									
Adair	4	\$ 1,397,326.08	-14.97	5	\$ 8,826,253.80	4.14	Yes	Two Firms (E)	\$ 2,201,267.70
Casey				6	\$ 2,648,992.35	-1.50	Yes	Five Firms (F)	\$ 511,255.52
Clinton				5	\$ 2,379,656.16	1.86	Yes	Two Firms (G)	\$ 539,230.09
Pulaski	2	\$ 829,668.70	-7.54	9	\$ 5,563,910.80	3.93	Yes	Four Firms (H)	\$ 1,375,955.14
Rockcastle	4	\$ 1,087,534.30	-24.59	4	\$ 1,640,863.33	2.90	Yes	Six Firms (I)	\$ 388,884.61
Wayne				5	\$ 2,638,123.30	6.76	Yes	Three Firms (J)	\$ 727,066.78
TOTAL (WITH ASPHALT PLANTS)	10	\$ 3,314,529.08	-17.33	34	\$23,697,799.74	2.99			
TOTAL (DISTRICT 8)	22	\$ 7,113,228.85	-20.80	51	\$39,444,453.39	2.16			\$ 9,060,636.59

(A) These firms include Gaddie-Shamrock, Mago Construction, and Nally & Haydon Surfacing

(B) These firms include The Allen Company, ATS Construction, Elmo Greer & Sons, Hinkle Contracting, Lexington Quarry, Lincoln County Ready Mix, Mago Construction, Nally & Haydon Surfacing

(C) These firms include Elmo Greer & Sons, Gaddie-Shamrock, Hinkle Contracting and Mago Construction

(D) These firms include Gaddie-Shamrock, Mago Construction, and Nally & Haydon Surfacing

(E) These firms include Gaddie-Shamrock and Nally & Haydon Surfacing

(F) These firms include The Allen Company, Elmo Greer & Sons, Hinkle Contracting, Mago Construction, and Nally & Haydon Surfacing

(G) These firms include Gaddie-Shamrock and Mago Construction

(H) These firms include The Allen Company, Elmo Greer & Sons, Hinkle Contracting and Mago Construction

(I) These firms include The Allen Company, ATS Construction, Elmo Greer & Sons, Lexington Quarry, Hinkle Contracting, and Mago Construction

(J) These firms include Gaddie-Shamrock, Hinkle Contracting, and Mago Construction

Table 6.33: Summary Statistics for District 8 Firms

VARIABLES	Elmo Greer & Sons		Gaddie-Shamrock		Hinkle Contracting		Mago Construction	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.249	0.433	0.204	0.405	0.202	0.402	0.179	0.384
Distance Variables								
Distance (0 to 10 miles) [reference variable]	0.112	0.316	0.0563	0.231	0.0810	0.273	0.0684	0.253
Distance (11 to 20 miles)	0.141	0.348	0.134	0.342	0.169	0.376	0.219	0.414
Distance (21 to 30 miles)	0.101	0.302	0.169	0.376	0.169	0.376	0.281	0.45
Distance (31 to 40 miles)	0.199	0.4	0.127	0.334	0.224	0.417	0.167	0.373
Distance (41 to 50 miles)	0.191	0.394	0.232	0.424	0.188	0.391	0.132	0.338
Distance (51 to 60 miles)	0.256	0.437	0.282	0.451	0.168	0.374	0.133	0.34
Other Control Variables								
Jobs Under Contract	11.51	2.959	2.831	2.291	10.01	2.944	6.147	2.196
Engineer's Estimate	578,252	1.63E+06	584,780	833,127	526,064	1.32E+06	638,763	1.62E+06
Competitive Variables								
Number of Competitor Service Areas	7.578	3.653	7.789	3.008	8	3.767	8.968	3.021
Zero other competitive bid proposal purchased [reference variable]	0.134	0.341	0.127	0.334	0.177	0.382	0.0544	0.227
One other competitive bid proposal purchased	0.697	0.46	0.585	0.495	0.512	0.5	0.446	0.497
Two other competitive bid proposals purchased	0.162	0.37	0.282	0.451	0.267	0.443	0.302	0.459
Three or more other competitive bid proposals purchased	0.00722	0.0848	0.00704	0.0839	0.0433	0.204	0.198	0.399
County Variables								
Project in same county-no rival	0.209	0.408	0.0986	0.299	0.136	0.343	0.128	0.334
Project in same county-rival	0.0397	0.196	0	-	0	-	0.0105	0.102
Project in adjacent county-no rival [reference variable]	0.231	0.422	0.352	0.479	0.294	0.456	0.277	0.448
Project in adjacent county-rival	0.520	0.501	0.549	0.499	0.571	0.495	0.584	0.493
Observations	277		142		531		570	

Table 6.34: Regression results for District 8 Firms

VARIABLES	Elmo Greer & Sons		Gaddie-Shamrock		Hinkle Contracting		Mago Construction	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.151*** (0.0530)	-0*** (0)	-0.0565 (0.0647)	0.0279 (0.0580)	0.0177 (0.0352)	0.117*** (0.0447)	-0.454*** (0.0581)	-0.249*** (0.0635)
Distance (21 to 30 miles)	-0.573*** (0.0868)	-0*** (0)	-0.755*** (0.119)	-0.575*** (0.205)	-0.0850** (0.0401)	0.0781* (0.0432)	-0.727*** (0.0514)	-0.425*** (0.0716)
Distance (31 to 40 miles)	-0.782*** (0.0492)	-0*** (0)	-0.871*** (0.0873)	-0.665*** (0.188)	-0.0904** (0.0448)	0.0721 (0.0441)	-0.829*** (0.0478)	-0.505*** (0.0724)
Distance (41 to 50 miles)	-0.807*** (0.0472)	-0*** (0)	-0.872*** (0.0882)	-0.663*** (0.190)	-0.108** (0.0465)	0.0517 (0.0432)	-0.862*** (0.0479)	-0.515*** (0.0742)
Distance (51 to 60 miles)	-0.775*** (0.0493)	-0*** (0)	-0.865*** (0.0878)	-0.666*** (0.187)	-0.124*** (0.0475)	0.0399 (0.0431)	-0.889*** (0.0491)	-0.545*** (0.0763)
Jobs Under Contract	0.0118*** (0.00347)	0*** (0)	0.00232 (0.00409)	0.00147 (0.00386)	-0.00162 (0.00210)	-0.00149 (0.00187)	0.00350 (0.00440)	0.00231 (0.00360)
Engineer's Estimate	3.73e-10 (3.07e-09)	0 (0)	7.41e-10 (1.12e-08)	7.16e-09 (1.30e-08)	6.13e-09*** (2.21e-09)	-5.43e-09* (2.80e-09)	-4.65e-10 (3.30e-09)	2.63e-09 (2.38e-09)
Potential Competitors	-0.0151*** (0.00356)	-0*** (0)	-0.000555 (0.00240)	0.000106 (0.00240)	-0.00408** (0.00176)	-0.00166 (0.00144)	-0.0188*** (0.00492)	-0.0114*** (0.00415)
One competitive bid proposal purchased	-0.289*** (0.0644)	-0*** (0)	-0.199 (0.123)	-0.239* (0.139)	-0.881*** (0.0365)	-0.725*** (0.0591)	-0.470*** (0.0552)	-0.189*** (0.0620)
Two competitive bid proposals purchased	-0.304*** (0.0683)	-0*** (0)	-0.218* (0.123)	-0.266* (0.139)	-0.906*** (0.0325)	-0.754*** (0.0555)	-0.510*** (0.0574)	-0.214*** (0.0679)
Three or more competitive bid proposals purchased	-0.562*** (0.201)	-0 (0)	-0.204 (0.144)	-0.271 (0.177)	-0.888*** (0.0373)	-0.739*** (0.0585)	-0.632*** (0.0572)	-0.273*** (0.0709)
Project in same county-rival		0 (0)						0.182** (0.0715)
Project in adjacent county-no rival		-1*** (0)		-0.158 (0.112)		-0.277*** (0.0693)		-0.380*** (0.0842)
Project in adjacent county-rival		-1*** (0)		-0.200* (0.116)		-0.356*** (0.0769)		-0.527*** (0.0793)
Constant	1.070*** (0.0457)	1*** (0)	1.072*** (0.0554)	1.096*** (0.0679)	1.059*** (0.0390)	1.057*** (0.0329)	1.488*** (0.0811)	1.278*** (0.0735)
Observations	277	277	142	142	531	531	570	570
R-squared	0.831	1.000	0.859	0.866	0.864	0.892	0.577	0.692

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.35: Additional regression results for District 8 firms and firms outside District 8

VARIABLES	Elmo Greer & Sons			Gaddie-Shamrock			Hinkle Contracting			Mago Construction		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0 (0)	-0 (0)	0.00677 (0.00842)							0.182** (0.0715)	0.143* (0.0767)	0.423*** (0.0733)
Project in adjacent county-no rival	-1*** (0)	-1*** (0)		-0.158 (0.112)	-0.0981 (0.0845)		-0.277*** (0.0693)	-0.244*** (0.0650)		-0.380*** (0.0842)	-0.296*** (0.0842)	
Project in adjacent county-rival	-1*** (0)		-0.922*** (0.0752)	-0.200* (0.116)		-0.669*** (0.232)	-0.356*** (0.0769)		-0.683*** (0.111)	-0.527*** (0.0793)		-0.364*** (0.0605)
Project in adjacent county-Allen Company		-1*** (0)			-0.112 (0.0958)			-0.341*** (0.0759)			-0.314*** (0.0822)	
Project in adjacent county-ATS Construction		-1*** (0)						-0.391*** (0.0843)			-0.427*** (0.0827)	
Project in adjacent county-Elmo Greer & Sons					-0.107 (0.103)			-0.316*** (0.0715)			-0.357*** (0.0823)	
Project in adjacent county-Gaddie-Shamrock		-1*** (0)						-0.318*** (0.0719)			-0.480*** (0.0962)	
Project in adjacent county-Glass Paving					-0.0714 (0.0505)						-0.351*** (0.0814)	
Project in adjacent county-Hinkle Contracting		-1*** (0)			-0.116 (0.0723)						-0.384*** (0.0808)	
Project in adjacent county-Kay & Kay Contracting								-0.0136 (0.0143)			-0.00105 (0.0115)	
Project in adjacent county-Lexington Quarry		-1*** (0)						-0.328*** (0.0749)			-0.479*** (0.0857)	
Project in adjacent county-Lincoln County Ready Mix		-0*** (0)						0.0488* (0.0251)			-0.381*** (0.0650)	
Project in adjacent county-Mago Construction		-1*** (0)			-0.157* (0.0863)			-0.300*** (0.0706)				
Project in adjacent county-Nally & Haydon		-1*** (0)			-0.152* (0.0892)			-0.282*** (0.0697)			-0.448*** (0.0829)	
Project in adjacent county-Scotty's Contracting					-0.0608 (0.0430)						-0.412*** (0.0833)	
Project in Cumberland County						0.113 (0.0864)			-0.682*** (0.115)			-0.393*** (0.0605)
Project in Lincoln County			-0.906*** (0.0903)			-0.660*** (0.237)			-0.691*** (0.108)			-0.361*** (0.0620)
Project in McCreary County			-0.916*** (0.0812)			-0.643** (0.248)			-0.335 (0.249)			0.0912 (0.367)
Project in Russell County			-0.927*** (0.0710)			0.101 (0.0802)			-0.686*** (0.110)			-0.371*** (0.0618)
Constant	1*** (0)	1*** (0)	0.992*** (0.00895)	1.096*** (0.0679)	1.064*** (0.0633)	0.979*** (0.0263)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	1.278*** (0.0735)	1.264*** (0.0818)	1.227*** (0.0737)
Observations	277	277	277	142	142	142	531	531	531	570	570	570
R-squared	1.000	1.000	0.983	0.866	0.864	0.973	0.892	0.893	0.942	0.692	0.710	0.773

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.35 (continued)

VARIABLES	Glass Paving (District 3)			Scotty's Contracting and Stone (District 3)			Nally & Haydon Surfacing (District 4)			The Allen Company (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.0179 (0.0188)	0.0160 (0.0286)	0.0242 (0.0262)	-0.181* (0.108)	-0.166 (0.112)	-0.218* (0.114)				0.241** (0.0959)	0.204** (0.0840)	-0*** (0)
Project in adjacent county-no rival	-0.933*** (0.0471)	-0.931*** (0.0526)		-0.189*** (0.0625)	-0.0616 (0.0731)		-0.288** (0.111)	-0.0603 (0.0698)		-0.177*** (0.0637)	-0.142** (0.0576)	
Project in adjacent county-rival	-0.955*** (0.0504)		-0.986*** (0.0879)	-0.544*** (0.0708)		-0.648*** (0.106)	-0.371*** (0.110)		-1*** (0)	-0.424*** (0.0671)		-1*** (0)
Project in adjacent county-Allen Company								-0.0718 (0.0553)				
Project in adjacent county-ATS Construction								-0.0783 (0.0522)			-0.678*** (0.0720)	
Project in adjacent county-Elmo Greer & Sons											-0.463*** (0.0766)	
Project in adjacent county-Gaddie-Shamrock		-0.933*** (0.0619)			-0.277*** (0.0814)			-0.209*** (0.0803)			-0.285*** (0.0625)	
Project in adjacent county-Glass Paving					-0.635*** (0.126)			-0.0967** (0.0448)				
Project in adjacent county-Hinkle Contracting								-0.102 (0.0620)			-0.385*** (0.0683)	
Project in adjacent county-Kay & Kay Contracting											0.120*** (0.0378)	
Project in adjacent county-Lexington Quarry								-0.112* (0.0580)			-0.445*** (0.0693)	
Project in adjacent county-Lincoln County Ready Mix								-0.129** (0.0588)				
Project in adjacent county-Mago Construction		-0.921*** (0.0545)			-0.248** (0.0986)			-0.163*** (0.0551)			-0.331*** (0.0765)	
Project in adjacent county-Nally & Haydon		-0.960*** (0.0374)			-0.273*** (0.0964)						-0.307*** (0.0640)	
Project in adjacent county-Scotty's Contracting		-0.962*** (0.0896)						-0.0584 (0.0639)				
Project in Cumberland County			-0.997*** (0.0883)			-0.652*** (0.112)			-1*** (0)			
Project in Lincoln County									-1*** (0)			-0*** (0)
Project in McCreary County												
Project in Russell County			-0.996*** (0.0903)			-0.660*** (0.111)			-1*** (0)			-1*** (0)
Constant	0.990*** (0.0204)	0.999*** (0.0611)	0.972*** (0.0332)	1.024*** (0.0426)	1.065*** (0.0506)	0.960*** (0.0340)	1.048*** (0.0468)	1.037*** (0.0846)	1*** (0)	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)
Observations	146	146	146	339	339	339	291	291	291	336	336	336
R-squared	0.842	0.842	0.848	0.740	0.749	0.849	0.862	0.853	1.000	0.788	0.834	1.000

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.35 (continued)

VARIABLES	ATS Construction (District 7)			Lexington Quarry (District 7)			Lincoln County Ready Mix (District 7)			Kay & Kay Contracting (District 11)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival												
Project in adjacent county-no rival	-0.300 (0.198)	-0.290 (0.204)		-0.177 (0.195)	0.0911 (0.259)		-0.330* (0.183)	-0.341* (0.185)		-0.345** (0.159)	-0.950*** (0.194)	
Project in adjacent county-rival	-0.314 (0.196)		-0.332* (0.198)	-0.254 (0.192)		-0.283 (0.195)	-0.540*** (0.187)		-0.739*** (0.224)	-0.0593 (0.0762)		-0.0107 (0.0715)
Project in adjacent county-Allen Company		-0.311 (0.201)			0.0637 (0.259)			-0.284 (0.226)			-0.971*** (0.177)	
Project in adjacent county-ATS Construction					-0.278 (0.198)			-0.503*** (0.190)				
Project in adjacent county-Elmo Greer & Sons		-0.284 (0.204)			0.0814 (0.258)			-0.547*** (0.188)			-0.0469 (0.0570)	
Project in adjacent county-Gaddie-Shamrock								-0.487*** (0.187)				
Project in adjacent county-Glass Paving												
Project in adjacent county-Hinkle Contracting		-0.299 (0.203)			0.0761 (0.259)			-0.570*** (0.190)			-0.681*** (0.235)	
Project in adjacent county-Kay & Kay Contracting								0.00291 (0.0334)				
Project in adjacent county-Lexington Quarry		-0.339* (0.201)						-0.809*** (0.204)				
Project in adjacent county-Lincoln County Ready Mix		0.0143 (0.0153)			-0.0451 (0.0456)						0.0633 (0.127)	
Project in adjacent county-Mago Construction		-0.306 (0.202)			0.0270 (0.261)			-0.540*** (0.194)			-0.914*** (0.155)	
Project in adjacent county-Nally & Haydon		-0.321 (0.200)			0.0317 (0.264)			-0.652*** (0.197)				
Project in adjacent county-Scotty's Contracting												
Project in Cumberland County												
Project in Lincoln County			-0.331* (0.200)			-0.282 (0.197)			0.128 (0.225)			-0.184 (0.167)
Project in McCreary County												-0.397** (0.179)
Project in Russell County									-0.745*** (0.223)			-0.161 (0.155)
Constant	0.983*** (0.0286)	0.955*** (0.0549)	1.005*** (0.0150)	0.975*** (0.107)	0.936*** (0.163)	1.133*** (0.0930)	0.947*** (0.190)	1.042*** (0.228)	0.859*** (0.190)	1.030*** (0.193)	0.699*** (0.207)	1.014*** (0.199)
Observations	283	283	283	239	239	239	229	229	229	62	62	62
R-squared	0.883	0.884	0.888	0.702	0.739	0.852	0.473	0.538	0.668	0.742	0.872	0.783

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed.

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.42: District 8

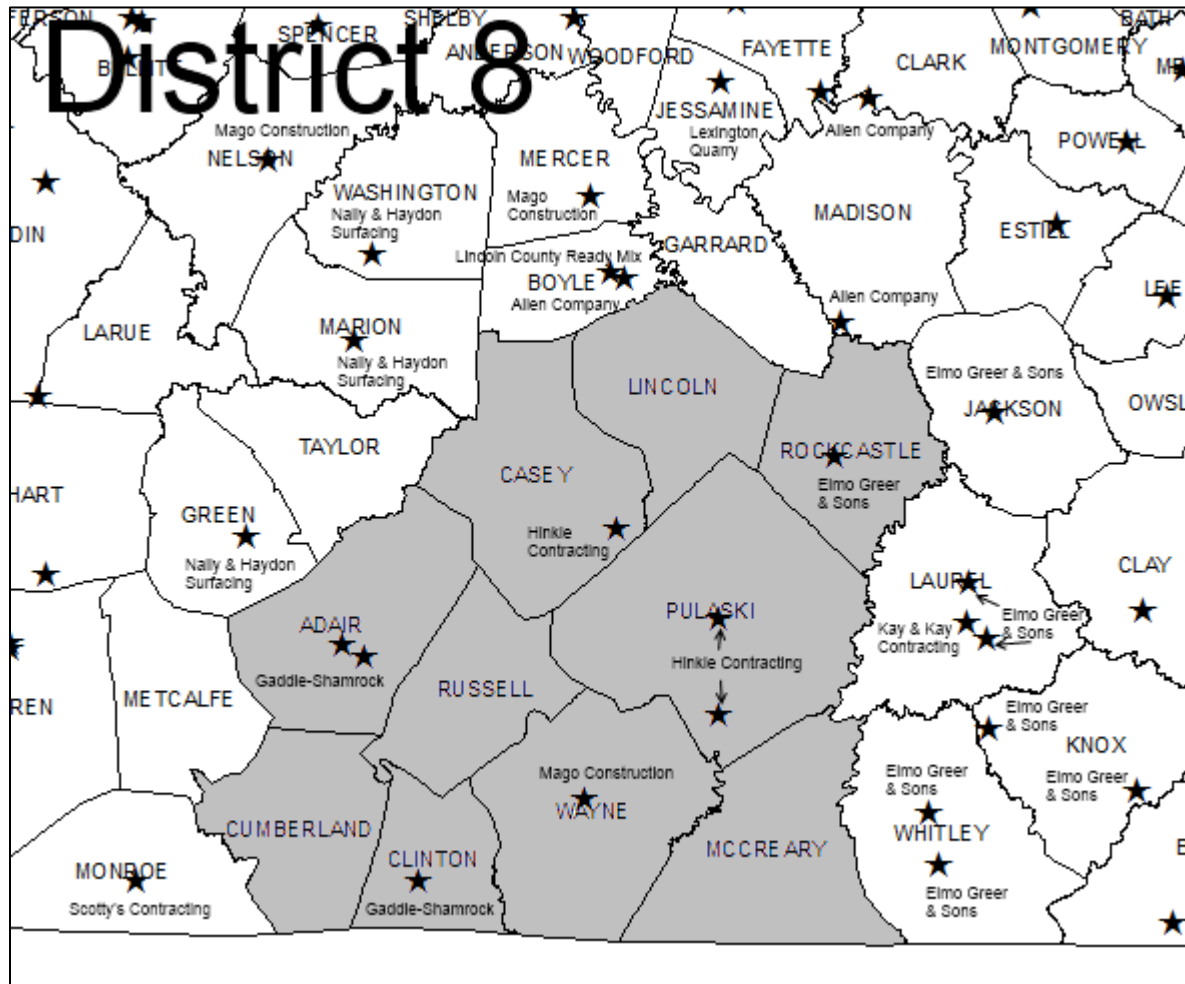


Figure 6.43: Elmo Greer & Sons Service Area

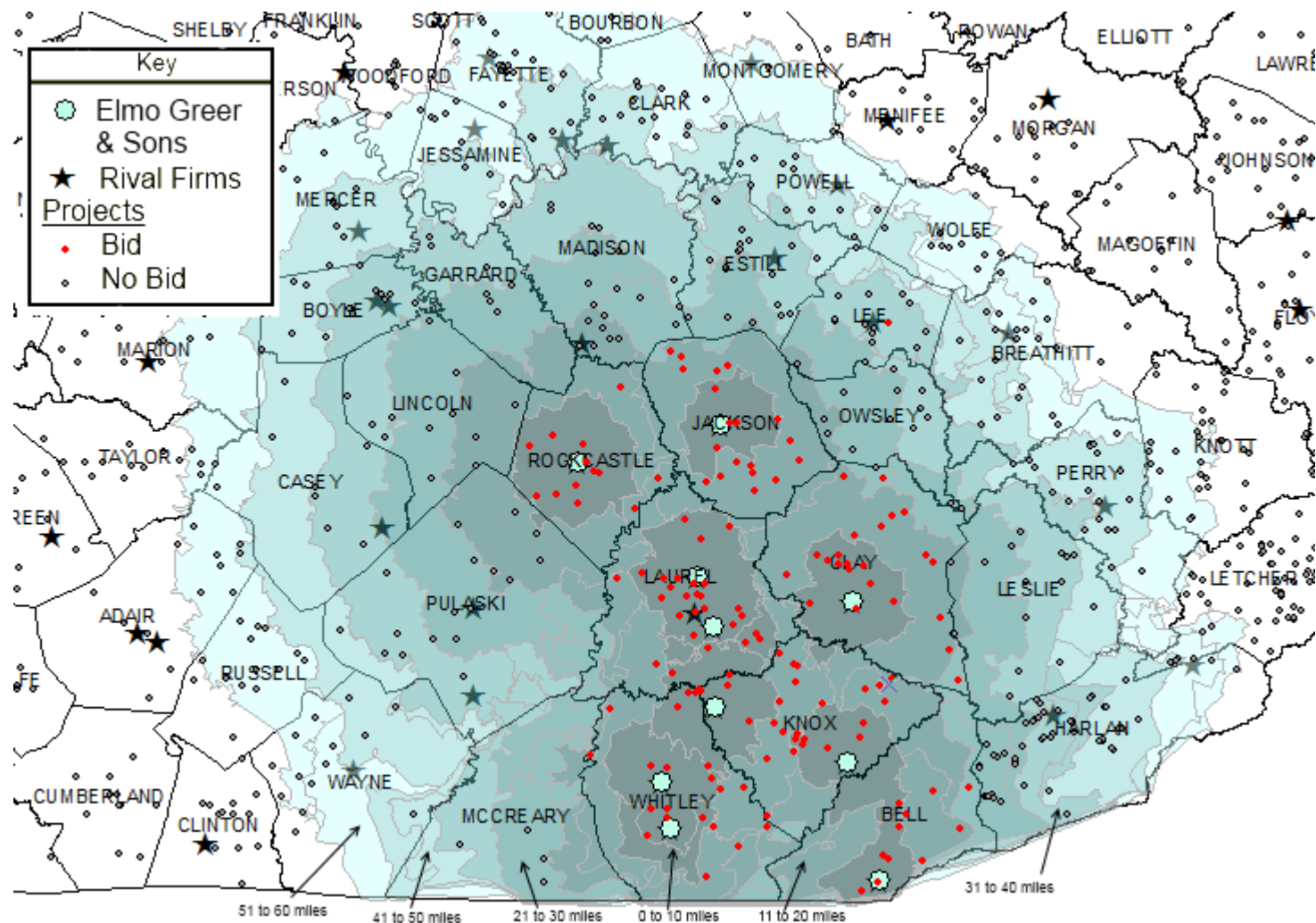


Figure 6.44: Gaddie-Shamrock Service Area

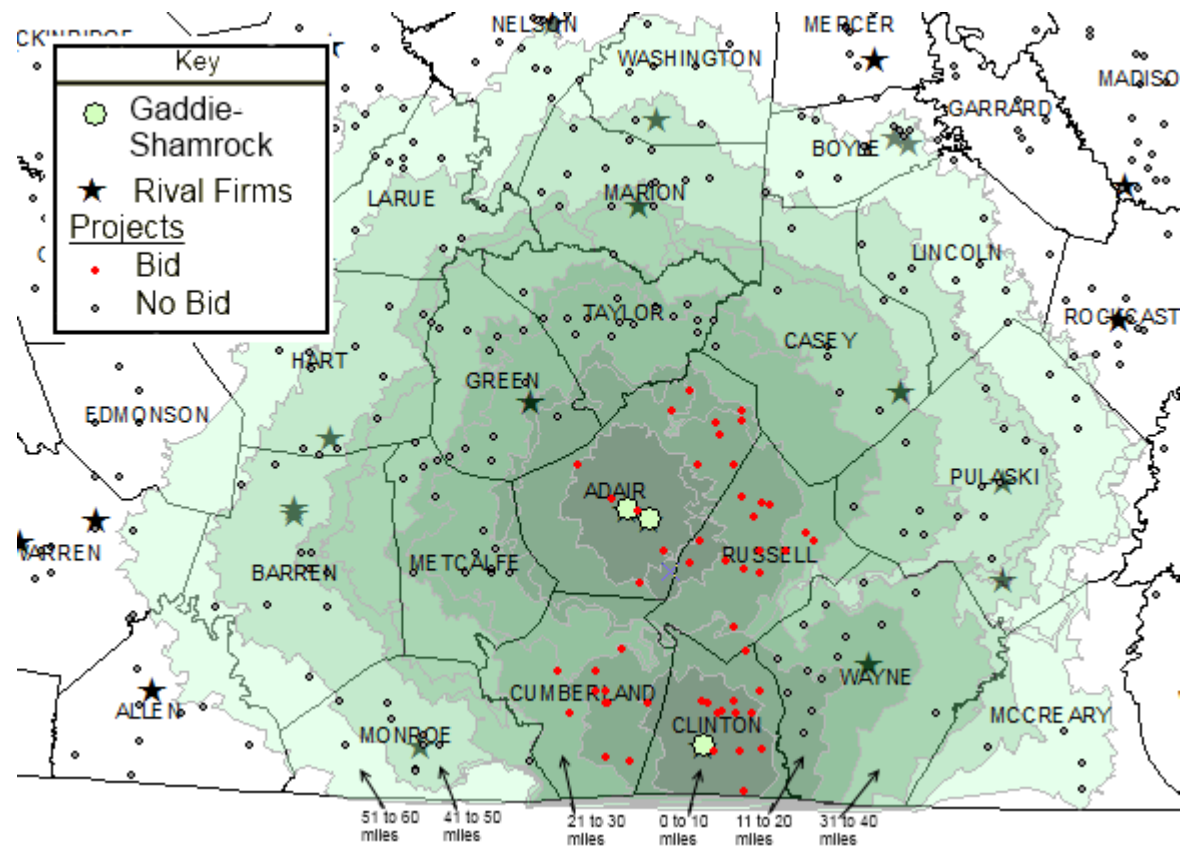


Figure 6.45: Hinkle Contracting Service Area

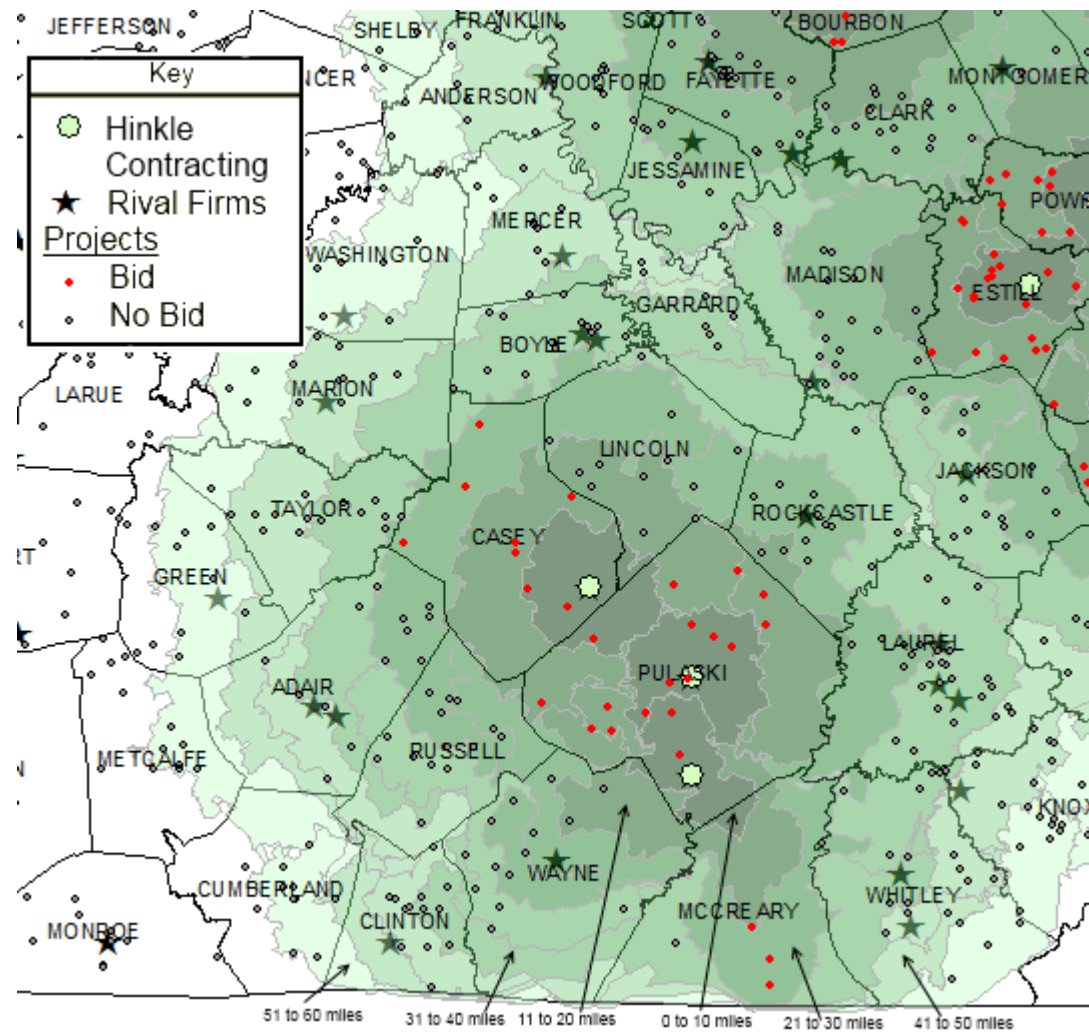
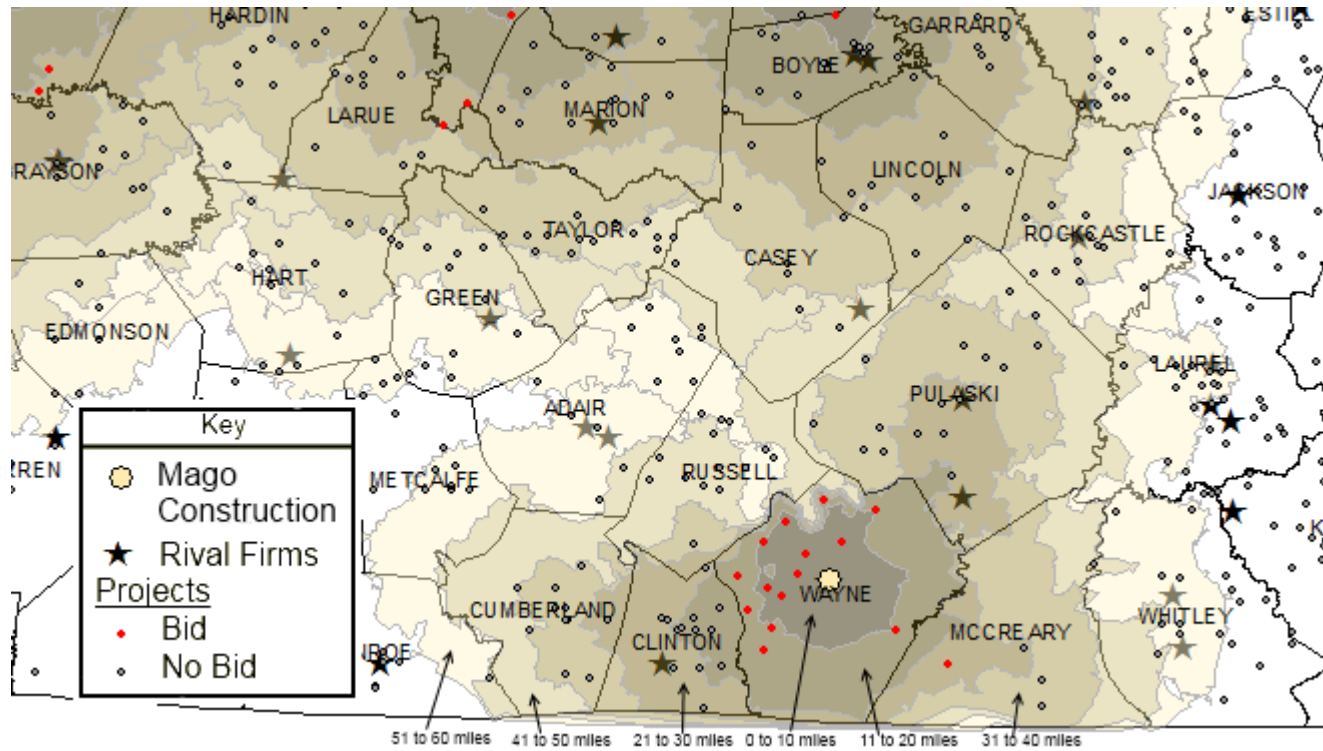


Figure 6.46: Mago Construction Service Area



6.10 District 9 – Eastern Kentucky

District 9 consists of firms located in the northeastern counties of Kentucky along the Ohio River (see Figure 6.47). There are five firms that have plants located in this district and that compete on projects: Blacktop Industries, H.G. Mays, Hinkle Contracting, and Mountain Enterprises. The Walker Company also bids on projects in Bath County. There is evidence of tacit collusion in all the counties. In Mason and Lewis Counties there is evidence of tacit collusion but it has no noticeable effect on the bid levels because competition is so fierce. Hinkle Contracting either is the primary bidder in a county or refuses to bid on projects. The other firms in turn do not bid where Hinkle Contracting bids or has their asphalt plant. There are exceptions such as Elliott County where Blacktop Industries and Mountain Enterprises bid on projects. The result of this tacit collusion is that there are single-bid contracts which increase bids \$5,996,119.63 above the competitive bid level. The competitive bids average 16.19 percent below the engineer's estimate while the single-bid contracts average 2.17 percent above the engineer's estimate.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and results tables are provided in Table 6.36, Table 6.37, Table 6.38, and Table 6.39. A map for each firm with an asphalt plant in District 9 follows the tables. The additional regression results found in Table 6.39 includes all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.10.1 Firms with Asphalt Plants in District 9

BLACKTOP INDUSTRIES

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Blacktop Industries is a West Virginia firm that has an asphalt plant in Boyd County in District 9. They bid on their first project mid-2006, and primarily bid on projects during 2007. Their primary competitor in this district is Mountain Enterprises. They bid on 11 projects in District 9 and were awarded two of the projects. The contracted value of all of the 11 projects was \$3,064,854.10. The average number of bidders on these projects was 2.00 bidders. There are no single-bid contracts on any of these projects. The 11 projects average 3.30 percent below the engineer's estimate.

FIRM BID FUNCTION

The bid function for Blacktop Industries is in Table 6.38. Since they did not start bidding until mid-2006, the data was restricted to all projects after their first bid on June 9, 2006. This leaves them with only 32 projects for this analysis. That is a very small amount, and so the maps were also used to understand their bidding behavior. Most coefficients in the regression are not significant. The engineer's estimate is negative and significant. This seems to indicate they bid on smaller projects. When the county variables are added, two of the distance variables are negative and significant. Also the "Project in adjacent county-no rival" is negative and significant. When the specific firm and county variables were added in the additional regression the "Greenup County" variable was negative and significant. It is hard to make many conclusions from these data simply because there are only 32 observations. Looking at Figure 6.48, they bid in the surrounding counties. It is hard to establish firm bidding patterns for Blacktop Industries with only 32 observations in the linear probability model. However, it is evident from the map they do not have much regard for county boundaries. They appear to be an aggressive bidder. More of their bidding behavior will be explored in the "Counties" section.

EATON ASPHALT PAVING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Eaton Asphalt Paving has one of their five plants located in District 9. Their other plants are located in District 6. Their primary competitors in this district are H.G. Mays, Hinkle Contracting, and Mountain Enterprises. They bid on 99 projects in Kentucky and 14 of those are in counties in District 9. The rest of the projects are in District 6. They were awarded contracts on four of the 14 projects. The contracted value of the 14 projects was \$5,640,808.70. The average number of bidders on these projects was 2.07 bidders. The contracted value of the 14 projects averaged 21.78 percent below the engineer's estimate.

FIRM BID FUNCTION

The bid function for Eaton Asphalt Paving is in Table 6.38. The bid function was analyzed in depth in the District 6 section. Only the important points of that analysis will be presented here. Distance is a major factor that influences whether or not Eaton Asphalt Paving bids on a project. The county variables are not significant which means they are treating all counties in a similar manner when all the other factors are controlled. However, when specific firms and counties are added in the additional regression in Table 6.39, it indicates they are less likely to

bid against ATS Construction, H.G. Mays, Hinkle Contracting, Mago Construction, Mountain Enterprises, Nally & Gibson Georgetown, and The Walker Company in counties they have their asphalt plants. They also avoid bidding in Bath, Elliott, Greenup, Lewis, and Nicholas Counties. I separated out the one eastern Eaton Asphalt Paving plant and ran a separate analysis. There were 105 observations in this regression. When the county variables were added only the “Project in same county-rival” was significant. With the specific firms, in the regression there are not any differences than the analysis with all of Eaton Asphalt Paving plants. When the specific county variables are added, only Nicholas County is significant and negative. The distance variables are also not significant in any of the specifications. When I compared the two regressions, the one with all of the Eaton Asphalt Paving plants included is more informative and used in this analysis. More of their bidding behavior will be explored in the “Counties” section and is analyzed in the District 6 section.

H.G. MAYS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

H.G. Mays has two of their three plants located in District 9. Their primary competitors in District 9 are Eaton Asphalt Paving, Hinkle Contracting and Mountain Enterprises. They bid on 38 projects in Kentucky and 20 of those are in counties in District 9. They also bid on eight projects in District 6 in Bracken and Robertson Counties. The rest of the projects are in District 5. They were awarded contracts on 16 of the 20 bids. The contracted value of all of the 20 projects was \$10,941,469.70. The average number of bidders on these projects was 1.75 bidders. Six of the 20 bids only had one bidder, H.G. Mays, and the contracted value of these projects averaged 0.77 percent above the engineer’s estimate. The contracted value of the other 14 competitive bids averaged 21.28 percent below the engineer’s estimate. The nature of this competition will be looked at more in-depth in the “Counties” section below.

FIRM BID FUNCTION

The bid function for H.G Mays is in Table 6.38. Only the highlights of the analysis done in District 5 will be presented here. The distance variables are not significant when the county variables are added. The county variables indicate that H.G. Mays is less likely to bid on projects in adjacent counties. In the additional regressions in Table 6.39, specific firms and counties were added and it shows they are less likely to bid on projects where The Allen Company, ATS Construction, Barrett Paving, Eaton Asphalt Paving, Hinkle Contracting, Lexington Quarry, Mago Construction, Mountain Enterprises, Nally & Gibson Georgetown and The Walker Company have

asphalt plants. They also are less likely to bid on projects in Bath, Elliott, and Greenup Counties. More of their bidding behavior will be explored in the “Counties” section.

HINKLE CONTRACTING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Hinkle Contracting has two of their 11 asphalt plants located in Rowan County in District 9. Their primary competitors in this district are H.G. Mays, Eaton Asphalt Paving, Mountain Enterprises, and The Walker Company. They bid on 107 projects in Kentucky and 14 of those projects are located in District 9 in Elliott, Nicholas, and Rowan Counties. They were awarded 13 out of the 14 projects. The contracted value of all of the 14 projects was \$16,629,883.60. The average number of bidders on these projects was 1.14 bidders. There were 12 single-bid contracts that average 1.29 percent below the engineer’s estimate. The remaining two bids have two bidders and average 7.93 percent below the engineer’s estimate. The factors that influence their bidding on projects will be highlighted in the next section.

FIRM BID FUNCTION

The bid function for The Hinkle Contracting is in Table 6.38. The bid function for Hinkle Contracting was described in detail in District 7. Only the interesting points will be highlighted here. When the county variables are added, the distance variables are no longer significant. Their county variables are both negative and significant. They are less likely to bid on projects in adjacent counties than in projects in the counties where they have their own asphalt plants. Specific firms and counties were added in the additional regressions in Table 6.39, and they are less likely to bid against The Allen Company, ATS Construction, Barrett Paving, H.G. Mays, Lexington Quarry, Mago Construction, Mountain Enterprises, Nally & Gibson Georgetown, and The Walker Company. They are also less likely to bid on projects in Bath, Elliott, Greenup and Lewis Counties. The question that is examined in the “Counties” section is whether or not this is an indication they are tacitly colluding with competitors.

MOUNTAIN ENTERPRISES

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mountain Enterprises has three of their 13 asphalt plants located in District 9. Their primary competitors located in District 9 are Blacktop Industries, Eaton Asphalt Paving, H.G. Mays, and Hinkle Contracting. Mountain Enterprises bid on 150 projects in Kentucky, and 41 of those projects are in District 9. They were awarded 35 of these 41 projects in District 9. The

contracted value of the 41 projects was \$16,796,448.08. The average number of bidders on these projects was 1.34 bidders. Twenty-eight of the 41 projects were only bid on by Mountain Enterprises. The contracted value of these 28 single-bid contracts averaged 3.67 percent above the engineer's estimate. For the other 13 projects with two or more bidders, the contracted value of the projects was 11.07 percent below the engineer's estimate.

FIRM BID FUNCTION

The results of the bid function for Mountain Enterprises can be found in Table 6.38. Without the county variables, any project beyond 20 miles decreases the probability that Mountain Enterprises will bid on a project. When the county variables are added this extends to 30 miles. The more projects Mountain Enterprises has under contract puts downward pressure on their bidding, but this effect goes away when the county variables are added. Competition is an important factor that influences their bidding. The more potential competitors for a project the less likely they are going to bid on the project. Also if competitors purchase bid proposals for a project it will decrease the probability they bid on a project. The county variables significantly impacted whether or not they bid on a project. They are less likely to bid on a project in an adjacent county than on projects in counties where they have asphalt plants. The magnitude is more negative when a rival firm is in the adjacent county. When specific firms and counties are added to the additional regressions, they are less likely to bid on projects in counties where H.G. Mays, Hinkle Contracting, Mago Construction, and The Walker Company have asphalt plants. They are also less likely to bid on projects in Bath and Nicholas Counties. More of their bidding behavior will be explored in the "Counties" section.

6.10.2 Counties in District 9

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.39). The additional regressions for firms outside District 9 will be discussed and are included in Table 6.39. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.38). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

BATH COUNTY

There are a total of six projects in Bath County and only one bidder, The Walker Company from District 7 and 10. The total contracted value of these projects is \$2,615,506.70 which averages 3.46 percent above the engineer's estimate. The average for competitive bids for District 9 projects is 16.19 percent below the engineer's estimate (see Table 6.36). The potential bidders in Bath County include Eaton Asphalt Paving, Hinkle Contracting, H.G. Mays, Mountain Enterprises, The Allen Company (District 7), ATS Construction (District 7), and Nally & Gibson Georgetown (District 7). According to the additional regressions in Table 6.39, Eaton Asphalt Paving, Hinkle Contracting, H.G. Mays, Mountain Enterprises, The Allen Company (District 7), ATS Construction (District 7), and Nally & Gibson Georgetown (District 7) are all less likely to bid on projects in Bath County. Since the regression has multicollinearity for The Walker Company, there is evidence they avoid bidding in counties where these other firms have asphalt plants (see Figure 6.41 or Figure 6.56). They do bid on a few projects in Powell County, but for the most part they avoid bidding where Hinkle Contracting has an asphalt plant. This tacit collusion results in single-bid projects that are \$513,947.07 above the competitive level.

ELLIOTT COUNTY

There are a total of four projects in Elliott County. The total contracted value of these projects is \$1,178,154.20. Two of the projects have two bidders and the other two projects only have one bidder. Blacktop Industries, Hinkle Contracting and Mountain Enterprises all bid on projects in Elliott County. Mountain Enterprises bids on all four projects. The only other firm that could bid on projects in Elliott County is The Walker Company, who is less likely to bid on projects in Elliott County. Hinkle Contracting and Mountain Enterprises are also less likely to bid on projects in Montgomery and Menifee Counties where The Walker Company has asphalt plants. It is possible they could put downward pressure on the bids. However, what is unique about the competition in Elliott County is that it does not put downward pressure on the bid levels. The contracted value for the multiple bid projects is 3.41 above the engineer's estimate while the contracted value of projects with multiple bidders in District 9 averages at 16.19 percent below the engineer's estimate. That is quite a disparity. Why is competition ineffective in driving down bid levels in this case? The firms seem to bid on the projects and they do not

seem to be avoiding bidding for any visible reason. If Walker Company bid on projects it could put downward pressure on bids on the single-bid projects and even on multiple bid projects. The tacit collusion between The Walker Company and Hinkle Contracting and Mountain Enterprises results in single-bid projects that are \$142,564.62 above the competitive level.

GREENUP COUNTY

There are a total of eight projects in Greenup County. The total contracted value of these projects is \$3,909,068.50. Seven of the projects only have one bidder and these seven projects' contracted value averages 2.99 percent above the engineer's estimate. The one competitive bid is 2.36 percent below the engineer's estimate. Mountain Enterprises wins every contract and the only other bidder is Blacktop Industries. Hinkle Contracting, Mountain Enterprises and Blacktop Industries are the firms that are in the best position to bid on projects in Greenup County. Looking at the additional regressions in Table 6.39, Hinkle Contracting is less likely to bid on projects in Greenup County and Mountain Enterprises avoids bidding on projects in counties where Hinkle Contracting has asphalt plants. There is evidence of tacit collusion between Hinkle Contracting and Mountain Enterprises. The result of this tacit collusion is that single-bid contracts are \$677,988.76 above the competitive level.

LEWIS COUNTY

There are a total of 10 projects in Lewis County. The total contracted value of these projects is \$4,747,340.60. There are eight bids with more than one bidder and two bids with only one bidder. Even with this the threat of competition drives the contracted value of the projects with one bidder to average 17.55 percent below the engineer's estimate. The multiple bid projects average 18.32 percent below the engineer's estimate. Eaton Asphalt Paving, H.G. Mays, and Mountain Enterprises actively bid on projects in Lewis County. Hinkle Contracting could reasonably bid on projects in Lewis County but does not. According to the additional regressions they are less likely to bid on projects in Lewis County when the other factors are controlled. Eaton Asphalt Paving, H.G. Mays and Mountain Enterprises all avoid bidding on projects where Hinkle Contracting has asphalt plants. There is evidence of tacit collusion between Hinkle Contracting and the other three firms. Even though there is tacit collusion, the competition among the other firms already drove the single-bid contracts to a level below the multi-bid average for District 9.

NICHOLAS COUNTY

There are a total of five projects in Nicholas County. The total contracted value of these projects is \$1,145,669.60. Of those five projects, four have one bidder. The contracted value of the four projects with one bidder averages 5.72 percent below the engineer's estimate. The projects with more than one bidder are 17.41 percent below the engineer's estimate (see Table 6.36). Hinkle Contracting bids on all five projects and wins them all. H.G. Mays is the other bidder. Other potential competitors include Eaton Asphalt Paving, Mago Construction, The Allen Company (District 7), ATS Construction (District 7), Lexington Quarry (District 7), Nally & Gibson Georgetown (District 7) and The Walker Company (District 7). There is evidence of tacit collusion between Hinkle Contracting and all of the other firms except Eaton Asphalt Paving. There is also evidence of tacit collusion between H.G. Mays and all of the other firms including Eaton Asphalt Paving. Even though H.G. Mays bids on that one project, it is not clear why they do not bid on the other four projects. The impact of this tacit collusion is not very high in monetary terms since bid levels remain below the engineer's estimate and only raises the single-bid contracts \$98,069.27 above the competitive level.

COUNTIES WITH ASPHALT PLANTS

BOYD AND CARTER COUNTIES

Mountain Enterprises has asphalt plants in both Boyd and Carter Counties. Blacktop Industries also has a plant in Boyd County. Carter County borders Rowan County and Hinkle Contracting is the only other potential bidder in Boyd and Carter Counties. Each county will be analyzed individually in the next two paragraphs.

In Boyd County, there are 10 projects that have a contracted value of \$3,041,154.61. Two of the projects have multiple bidders Blacktop Industries and Mountain Enterprises while the other nine projects only have one bidder. Blacktop Industries only started bidding half way through 2006. That is one reason why Mountain Enterprises is the only bidder on the projects. According to the additional regressions, Hinkle Contracting is less likely to bid on a project in a county where Mountain Enterprises has an asphalt plant, and in turn Mountain Enterprises avoids bidding on projects where Hinkle Contracting has asphalt plants (see Table 6.39). These two firms tacitly collude. If Hinkle Contracting bid on the projects in Boyd County it would put

downward pressure on bids. Currently, the single-bid contracts are \$528,984.95 above the competitive level of District 9.

In Carter County, there is evidence of tacit collusion between Mountain Enterprises and Hinkle Contracting. There are 10 projects and Mountain Enterprises bids on all of them. Blacktop Industries only bids on one of the projects. The nine single-bid contracts average 6.86 percent above the engineer's estimate while the one project with two bidders is 4.68 percent below the engineer's estimate. The projects in Carter County are within a reasonable distance for Hinkle Contracting but they do not bid (see Figure 6.51). Mountain Enterprises could reasonably bid on projects in Rowan County but they do not (see Figure 6.52). This is similar to what is occurring in Boyd County. The result of this tacit collusion is that bids are \$902,450.85 above the competitive level.

FLEMING AND MASON COUNTY

H.G. Mays has asphalt plants in Fleming and Mason Counties. Eaton Asphalt Paving has an asphalt plant in Mason County. There are 11 projects in Fleming County and four projects in Mason County. These two firms are the primary bidders on the projects in these two counties. Each county will be looked at separately in the next two paragraphs.

In Fleming County, out of the 11 projects six of them only had one bidder, H.G. Mays. What is interesting is that Eaton Asphalt Paving did not start bidding on projects in Fleming County until 2007. However, they actively bid on the projects in Mason County. The six single-bid projects contracted value average 0.77 percent above the engineer's estimate, while the contracted value of the other five multi-bid projects averages 20.85 percent below the engineer's estimate. It is not exactly clear why Eaton Asphalt did not bid on projects until 2007, but when they started bidding regularly it put downward pressure on the bids. Other potential firms that could bid on projects in Fleming County include Hinkle Contracting, Mountain Enterprises, and The Walker Company. There is evidence that Hinkle Contracting, Mountain Enterprises, and The Walker Company avoid bidding against H.G. Mays, and in turn H.G. Mays avoids bidding against Hinkle Contracting, Mountain Enterprises, and The Walker Company. This coordination of bid results in bid levels that are \$527,234.72 above the competitive level.

Both Eaton Asphalt Paving and H.G. Mays actively bid on the projects in Mason County. This competition puts downward pressure on the bid levels for the four projects. The four

projects with a contractual value of only \$970,112.40 average 22.57 percent below the engineer's estimate. Like Fleming County, Hinkle Contracting, Mountain Enterprises, and The Walker Company avoid bidding where H.G Mays has an asphalt plants. There is also evidence that Mago Construction and Barrett Paving avoid bidding against H.G. Mays, while Mago Construction and The Walker Company avoid bidding against Eaton Asphalt Paving. While there is evidence of tacit collusion in Mason County, the financial impact is negligible because competition is so fierce between Eaton Asphalt Paving and H.G. Mays.

ROWAN COUNTY

Hinkle Contracting has two asphalt plants in Rowan County. There are eight projects with a contracted value of \$15,215,417.00 and only Hinkle Contracting bids on the projects. They average 0.93 percent above the engineer's estimate. The potential competitors include Eaton Asphalt Paving, H.G. Mays, Mountain Enterprises and Walker Company. There is evidence in the additional regressions in Table 6.39 that H.G. Mays and Mountain Enterprises avoid bidding on projects where Hinkle Contracting has an asphalt plant. The Walker Company also avoids bidding against Hinkle Contracting in Rowan County. This is verified by looking at the maps for these three firms (see Figure 6.50, Figure 6.51, Figure 6.52, and Figure 6.56). This coordination of bid results in bid levels that are \$2,604,879.39 above the competitive level.

CONCLUSION

In conclusion, the pattern of bidding that emerges in District 9 is sporadic. There are counties such as Mason and Lewis Counties where the bidding is very competitive and other counties such as Boyd and Greenup County where Mountain Enterprises dominates the bidding and Blacktop Industries occasionally bids on projects. Firms avoid bidding in Bath County where The Walker Company is the primary bidder, and there is evidence of tacit collusion in this county. Where there is evidence of tacit collusion bids are \$5,996,119.63 above the competitive bid level for District 9. This tacit collusion results in single-bid contracts that are well above the competitive level.

Table 6.36: Summary of Tacit Collusion for District 9 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Bath				6	\$ 2,615,506.70	3.46	Yes	Seven Firms (A)	\$ 513,947.07
Elliott	2	\$ 456,308.00	3.41	2	\$ 721,846.20	3.56	Yes	Three Firms (B)	\$ 142,564.62
Greenup	1	\$ 374,194.90	-2.36	7	\$ 3,534,873.60	2.99	Yes	Two Firms (C)	\$ 677,988.76
Lewis	8	\$ 3,921,117.40	-18.32	2	\$ 826,223.20	-17.55	Yes	Four Firms (D)	Competitive
Nicholas	1	\$ 209,000.40	-17.41	4	\$ 936,669.20	-5.72	Yes	Eight Firms (E)	\$ 98,069.27
TOTAL (WITHOUT ASPHALT PLANTS)	12	\$ 4,960,620.70	-13.30	21	\$ 8,635,118.90	-0.43			
WITH ASPHALT PLANTS									
Boyd	2	\$ 658,339.50	-14.95	8	\$ 2,382,815.11	6.01	Yes	Two Firms (C)	\$ 528,984.95
Carter	1	\$ 364,300.40	-4.68	9	\$ 3,915,188.07	6.86	Yes	Two Firms (C)	\$ 902,450.85
Fleming	5	\$ 5,095,442.80	-20.85	6	\$ 3,108,695.30	0.77	Yes	Four Firms (F)	\$ 527,234.72
Mason	4	\$ 970,112.40	-22.57				Yes	Seven Firms (G)	Competitive
Rowan				8	\$15,215,417.00	0.93	Yes	Three Firms (F)	\$ 2,604,879.39
TOTAL (WITH ASPHALT PLANTS)	12	\$ 7,088,195.10	-19.09	31	\$24,622,115.48	3.93			
TOTAL (DISTRICT 9)	24	\$ 12,048,815.80	-16.19	52	\$33,257,234.38	2.17			\$ 5,996,119.63

(A) These firms include The Allen Company, ATS Construction, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Nally & Gibson Georgetown, and The Walker Company

(B) These firms include Hinkle Contracting, Mountain Enterprises, and The Walker Company

(C) These firms include Hinkle Contracting and Mountain Enterprises

(D) These firms include Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, and Mountain Enterprises

(E) These firms include The Allen Company, ATS Construction, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Mago Construction, Nally & Gibson Georgetown, and The Walker Company

(F) These firms include H.G. Mays, Hinkle Contracting, Mountain Enterprises, and The Walker Company

(G) These firms include Barrett Paving, Eaton Asphalt Paving, H.G. Mays, Hinkle Contracting, Mago Construction, Mountain Enterprises, and The Walker Company

Table 6.37: Summary Statistics for District 9 Firms

VARIABLES	Blacktop Industries		Eaton Asphalt Paving		HG Mays		Hinkle Contracting		Mountain Enterprises	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.344	0.483	0.406	0.492	0.102	0.303	0.202	0.402	0.538	0.499
Distance Variables										
Distance (0 to 10 miles) [reference variable]	0	-	0.143	0.351	0.0456	0.209	0.0810	0.273	0.122	0.328
Distance (11 to 20 miles)	0.188	0.397	0.123	0.329	0.0643	0.246	0.169	0.376	0.226	0.419
Distance (21 to 30 miles)	0.0938	0.296	0.176	0.382	0.201	0.401	0.169	0.376	0.183	0.387
Distance (31 to 40 miles)	0.188	0.397	0.164	0.371	0.177	0.382	0.224	0.417	0.176	0.381
Distance (41 to 50 miles)	0.313	0.471	0.201	0.401	0.268	0.444	0.188	0.391	0.147	0.355
Distance (51 to 60 miles)	0.219	0.42	0.193	0.395	0.244	0.43	0.168	0.374	0.147	0.355
Other Control Variables										
Jobs Under Contract	0	-	4.635	2.007	2.365	1.632	10.01	2.944	10.12	4.295
Engineer's Estimate	569,605	1.17E+06	403,471	8.10E+05	552,908	1.48E+06	526,064	1.32E+06	504,063	9.44E+05
Competitive Variables										
Number of Competitor Service Areas	3.438	1.19	8.934	2.959	10.13	2.84	8	3.767	4.179	2.507
Zero other competitive bid proposal purchased [reference variable]	0	-	0.00410	0.064	0.0429	0.203	0.177	0.382	0.452	0.499
One other competitive bid proposal purchased	0.906	0.296	0.672	0.47	0.504	0.501	0.512	0.5	0.448	0.498
Two other competitive bid proposals purchased	0.0938	0.296	0.270	0.445	0.249	0.433	0.267	0.443	0.0932	0.291
Three or more other competitive bid proposals purchased	0	-	0.0533	0.225	0.204	0.403	0.0433	0.204	0.00717	0.0845
County Variables										
Project in same county-no rival	0	-	0.0246	0.155	0.0536	0.226	0.136	0.343	0.348	0.477
Project in same county-rival	0.156	0.369	0.0861	0.281	0.0107	0.103	0	-	0.0358	0.186
Project in adjacent county-no rival [reference variable]	0.250	0.44	0.320	0.467	0.223	0.416	0.294	0.456	0.265	0.442
Project in adjacent county-rival	0.594	0.499	0.570	0.496	0.713	0.453	0.571	0.495	0.351	0.478
Observations	32		244		373		531		285	

Table 6.38: Regression results for District 9 Firms

VARIABLES	Blacktop Industries		Eaton Asphalt Paving		HG Mays		Hinkle Contracting		Mountain Enterprises	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.0604 (0.337)	-0.873*** (0.290)	-0.0491 (0.0808)	-0.0666 (0.0839)	-0.379*** (0.107)	0.0414 (0.0710)	0.0177 (0.0352)	0.117*** (0.0447)	0.0358 (0.0363)	0.0452 (0.0302)
Distance (21 to 30 miles)	0.271 (0.403)	0 (0)	-0.245*** (0.0937)	-0.185* (0.0972)	-0.639*** (0.101)	0.000334 (0.118)	-0.0850** (0.0401)	0.0781* (0.0432)	-0.0853* (0.0444)	-0.0297 (0.0377)
Distance (31 to 40 miles)	0 (0)	-0.404 (0.349)	-0.392*** (0.101)	-0.323*** (0.106)	-0.721*** (0.0969)	-0.0701 (0.113)	-0.0904** (0.0448)	0.0721 (0.0441)	-0.336*** (0.0674)	-0.221*** (0.0566)
Distance (41 to 50 miles)	0.198 (0.285)	-0.224 (0.343)	-0.761*** (0.0750)	-0.687*** (0.0840)	-0.778*** (0.0948)	-0.128 (0.113)	-0.108** (0.0465)	0.0517 (0.0432)	-0.482*** (0.0691)	-0.326*** (0.0582)
Distance (51 to 60 miles)	-0.415 (0.288)	-0.840*** (0.294)	-0.778*** (0.0717)	-0.707*** (0.0793)	-0.804*** (0.0960)	-0.145 (0.115)	-0.124*** (0.0475)	0.0399 (0.0431)	-0.463*** (0.0688)	-0.371*** (0.0606)
Jobs Under Contract	0 (0)	0 (0)	0.00779 (0.0103)	0.00848 (0.0102)	-0.00106 (0.00686)	-0.00121 (0.00622)	-0.00162 (0.00210)	-0.00149 (0.00187)	-0.00698** (0.00298)	-0.00363 (0.00244)
Engineer's Estimate	-1.08e-07*** (3.74e-08)	-1.09e-07** (4.03e-08)	-4.82e-08*** (1.78e-08)	-4.49e-08*** (1.63e-08)	-3.02e-09 (4.36e-09)	-1.98e-09 (3.41e-09)	6.13e-09*** (2.21e-09)	-5.43e-09* (2.80e-09)	-2.04e-08 (1.51e-08)	-1.35e-08 (8.92e-09)
Potential Competitors	-0.0340 (0.0862)	0.00208 (0.110)	-0.0168** (0.00802)	-0.0172** (0.00816)	-0.0223*** (0.00532)	-0.0138*** (0.00508)	-0.00408** (0.00176)	-0.00166 (0.00144)	-0.0150*** (0.00528)	-0.0108* (0.00601)
One competitive bid proposal purchased	-0.0532 (0.155)	-0.172 (0.227)	-0.241*** (0.0803)	-0.0253 (0.0457)	-0.348*** (0.105)	-0.238 (0.147)	-0.881*** (0.0365)	-0.725*** (0.0591)	-0.491*** (0.0632)	-0.320*** (0.0574)
Two competitive bid proposals purchased			-0.108 (0.0779)	0.102 (0.0686)	-0.355*** (0.105)	-0.222 (0.150)	-0.906*** (0.0325)	-0.754*** (0.0555)	-0.548*** (0.0752)	-0.277*** (0.0789)
Three or more competitive bid proposals purchased			-0.282** (0.109)	-0.0486 (0.0940)	-0.367*** (0.107)	-0.225 (0.148)	-0.888*** (0.0373)	-0.739*** (0.0585)	-0.761*** (0.137)	-0.439*** (0.113)
Project in same county-rival				-0.109* (0.0656)		0.128 (0.0996)				0.0151 (0.0481)
Project in adjacent county-no rival		-0.704* (0.354)		-0.300*** (0.0877)		-0.653*** (0.133)		-0.277*** (0.0693)		-0.0994*** (0.0333)
Project in adjacent county-rival		-0.432 (0.265)		-0.310*** (0.0878)		-0.729*** (0.133)		-0.356*** (0.0769)		-0.418*** (0.0525)
Constant	0.585 (0.585)	1.480** (0.645)	1.162*** (0.102)	1.180*** (0.108)	1.355*** (0.0734)	1.210*** (0.0723)	1.059*** (0.0390)	1.057*** (0.0329)	1.163*** (0.0445)	1.108*** (0.0373)
Observations	32	32	244	244	373	373	531	531	279	279
R-squared	0.250	0.309	0.557	0.572	0.588	0.667	0.864	0.892	0.828	0.878

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.39: Additional regression results for firms in District 9 and firms outside District 9

VARIABLES	Blacktop Industries			Eaton Asphalt Paving			HG Mays			Hinkle Contracting			Mountain Enterprises		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival				-0.109* (0.0656)	-0.145** (0.0656)	-0.0173 (0.0277)	0.128 (0.0996)	0.252** (0.117)	0.218* (0.111)				0.0151 (0.0481)	0.0163 (0.0450)	0.0116 (0.0205)
Project in adjacent county-no rival	-0.704* (0.354)	-0.704* (0.354)		-0.300*** (0.0877)	-0.431*** (0.0902)		-0.653*** (0.133)	-0.408*** (0.144)		-0.277*** (0.0693)	-0.244*** (0.0650)		-0.0994*** (0.0333)	-0.0742** (0.0344)	
Project in adjacent county-rival	-0.432 (0.265)		-0.434 (0.278)	-0.310*** (0.0878)		-0.346*** (0.0880)	-0.729*** (0.133)		-0.374*** (0.128)	-0.356*** (0.0769)		-0.683*** (0.111)	-0.418*** (0.0525)		-0.819*** (0.0627)
Project in adjacent county-Allen Company							-0.406*** (0.148)			-0.341*** (0.0759)					
Project in adjacent county-ATS Construction					-0.462*** (0.0806)		-0.546*** (0.155)			-0.391*** (0.0843)					
Project in adjacent county-Barrett Paving					-0.0267 (0.0675)		-0.466*** (0.144)			-0.262*** (0.0667)					
Project in adjacent county-Blacktop Industries										0.0307** (0.0122)					
Project in adjacent county-Eaton Asphalt Paving							-0.450*** (0.145)			-0.0134 (0.0633)			0.108 (0.0689)		
Project in adjacent county-HG Mays					-0.533*** (0.116)					-0.318*** (0.0726)			-0.331*** (0.0773)		
Project in adjacent county-Hinkle Contracting					-0.650*** (0.111)		-0.541*** (0.141)						-0.464*** (0.0536)		
Project in adjacent county-Lexington Quarry							-0.499*** (0.148)			-0.328*** (0.0749)					
Project in adjacent county-Mago Construction					-0.405*** (0.119)		-0.420*** (0.151)			-0.300*** (0.0706)			-0.191** (0.0743)		
Project in adjacent county-Mountain Enterprises		-0.432 (0.265)			-0.658*** (0.133)		-0.525*** (0.137)			-0.331*** (0.0742)					
Project in adjacent county-Nally & Gibson Georgetown					-0.412*** (0.0782)		-0.538*** (0.156)			-0.354*** (0.0791)					
Project in adjacent county-Walker Company					-0.577*** (0.101)		-0.516*** (0.141)			-0.395*** (0.0832)			-0.223*** (0.0561)		
Project in Bath County						-0.762*** (0.127)		-0.518*** (0.125)		-0.702*** (0.107)					-0.814*** (0.0658)
Project in Elliott County			-0.448 (0.625)		-0.504*** (0.109)			-0.393*** (0.128)		-0.430* (0.247)			0.0928** (0.0464)		
Project in Greenup County			-0.944** (0.379)		-0.447*** (0.105)			-0.394*** (0.127)		-0.675*** (0.115)			0.0145 (0.0257)		
Project in Lewis County			-0.291 (0.461)		-0.354* (0.211)			-0.0923 (0.194)		-0.674*** (0.114)			0.0404 (0.0849)		
Project in Nicholas County					-0.811*** (0.117)		-0.228 (0.224)			0.0440 (0.0622)			-0.831*** (0.0610)		
Constant	1.480** (0.645)	1.480** (0.645)	1.613*** (0.534)	1.180*** (0.108)	1.309*** (0.120)	1.096*** (0.0972)	1.210*** (0.0723)	1.306*** (0.0974)	1.119*** (0.0535)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	1.108*** (0.0373)	1.144*** (0.0383)	1.049*** (0.0214)
Observations	32	32	32	244	244	244	373	373	373	531	531	531	279	279	279
R-squared	0.309	0.309	0.345	0.572	0.666	0.642	0.667	0.665	0.764	0.892	0.893	0.942	0.878	0.886	0.967

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.39 (continued)

VARIABLES	Barrett Paving (District 6)			Mago Construction (District 6)			The Allen Company (District 7)			ATS Construction (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	-0.0460 (0.0377)	-0.0894** (0.0412)	0.0267 (0.0330)	0.182** (0.0715)	0.143* (0.0767)	0.423*** (0.0733)	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)			
Project in adjacent county-no rival	-0.276*** (0.0736)	-0.334*** (0.0727)		-0.380*** (0.0842)	-0.296*** (0.0842)		-0.177*** (0.0637)	-0.142** (0.0576)		-0.300 (0.198)	-0.290 (0.204)	
Project in adjacent county-rival	-0.380*** (0.104)		-0.863*** (0.0782)	-0.527*** (0.0793)		-0.364*** (0.0605)	-0.424*** (0.0671)		-1*** (0)	-0.314 (0.196)		-0.332* (0.198)
Project in adjacent county-Allen Company					-0.314*** (0.0822)						-0.311 (0.201)	
Project in adjacent county-ATS Construction		-0.352*** (0.0790)			-0.427*** (0.0827)			-0.678*** (0.0720)				
Project in adjacent county-Barrett Paving					-0.449*** (0.100)			-0.251*** (0.0778)			-0.287 (0.203)	
Project in adjacent county-Blacktop Industries												
Project in adjacent county-Eaton Asphalt Paving		-0.193 (0.246)			-0.308*** (0.0825)							
Project in adjacent county-HG Mays		-0.289** (0.116)			-0.383*** (0.0780)			-0.244*** (0.0645)			-0.308 (0.201)	
Project in adjacent county-Hinkle Contracting		-0.401*** (0.0788)			-0.384*** (0.0808)			-0.385*** (0.0683)			-0.299 (0.203)	
Project in adjacent county-Lexington Quarry					-0.479*** (0.0857)			-0.445*** (0.0693)			-0.339* (0.201)	
Project in adjacent county-Mago Construction		-0.550*** (0.101)						-0.331*** (0.0765)			-0.306 (0.202)	
Project in adjacent county-Mountain Enterprises												
Project in adjacent county-Nally & Gibson Georgetown		-0.364*** (0.0819)			-0.361*** (0.0849)			-0.247*** (0.0651)			-0.331* (0.200)	
Project in adjacent county-Walker Company					-0.298*** (0.0845)			-0.392*** (0.0685)			-0.293 (0.202)	
Project in Bath County						-0.350*** (0.0652)			-1*** (0)			-0.337* (0.198)
Project in Elliott County												
Project in Greenup County												
Project in Lewis County						-0.305*** (0.0634)						
Project in Nicholas County			-0.882*** (0.0804)			-0.360*** (0.0647)			-1*** (0)			-0.340* (0.200)
Constant	1.179*** (0.0644)	1.317*** (0.101)	1.023*** (0.0476)	1.278*** (0.0735)	1.264*** (0.0818)	1.227*** (0.0737)	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)	0.983*** (0.0286)	0.955*** (0.0549)	1.005*** (0.0150)
Observations	182	182	182	570	570	570	336	336	336	283	283	283
R-squared	0.841	0.863	0.900	0.692	0.710	0.773	0.788	0.834	1.000	0.883	0.884	0.888

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.39 (continued)

VARIABLES	Lexington Quarry (District 7)			Nally & Gibson Georgetown (District 7)			The Walker Company (District 7)		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival									
Project in adjacent county-no rival	-0.177 (0.195)	0.0911 (0.259)		-1*** (0)	0* (0)		0.0786 (0.0561)	0.0776 (0.0580)	
Project in adjacent county-rival	-0.254 (0.192)		-0.283 (0.195)	-1*** (0)		0*** (0)	0.124 (0.0785)		0.00635 (0.00713)
Project in adjacent county-Allen Company		0.0637 (0.259)			0* (0)			0.101 (0.0748)	
Project in adjacent county-ATS Construction		-0.278 (0.198)			0** (0)			0.0850 (0.0859)	
Project in adjacent county-Barrett Paving		0.0483 (0.260)			0* (0)			0.0635 (0.0623)	
Project in adjacent county-Blacktop Industries					0 (0)				
Project in adjacent county-Eaton Asphalt Paving					0 (0)			-0.00610 (0.0268)	
Project in adjacent county-HG Mays		0.00508 (0.265)			0* (0)			0.0856 (0.0752)	
Project in adjacent county-Hinkle Contracting		0.0761 (0.259)			0* (0)			0.167* (0.0981)	
Project in adjacent county-Lexington Quarry					0* (0)			0.110 (0.0743)	
Project in adjacent county-Mago Construction		0.0270 (0.261)			0* (0)			0.0825 (0.0626)	
Project in adjacent county-Mountain Enterprises					0 (0)			0.108 (0.0709)	
Project in adjacent county-Nally & Gibson Georgetown		0.00107 (0.267)			0 (0)			0.102 (0.0716)	
Project in adjacent county-Walker Company		0.0810 (0.255)			0* (0)				
Project in Bath County			-0.286 (0.196)			0*** (0)			0.151 (0.0998)
Project in Elliott County									-0.00222 (0.00521)
Project in Greenup County									
Project in Lewis County									
Project in Nicholas County			-0.284 (0.194)			0*** (0)			-0.178 (0.110)
Constant	0.975*** (0.107)	0.936*** (0.163)	1.133*** (0.0930)	1*** (0)	1*** (0)	1*** (0)	1.014*** (0.0105)	0.975*** (0.0227)	1.005*** (0.00721)
Observations	239	239	239	270	270	270	245	245	245
R-squared	0.702	0.739	0.852	1.000	1.000	1.000	0.869	0.874	0.888

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.47: District 9

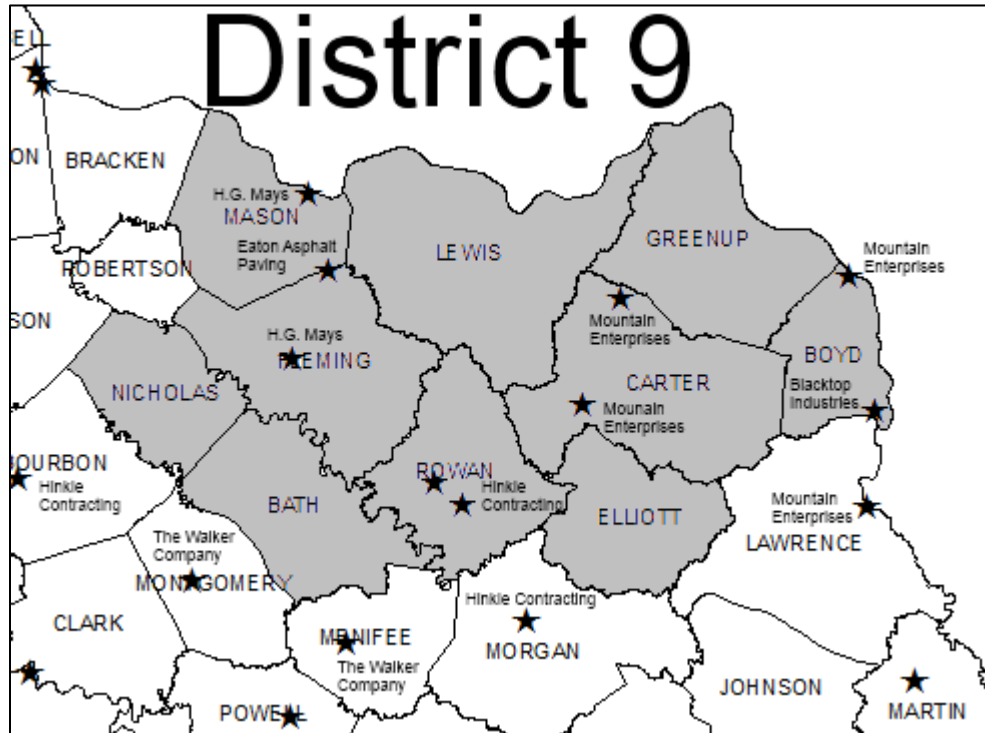


Figure 6.48: Blacktop Industries Service Area

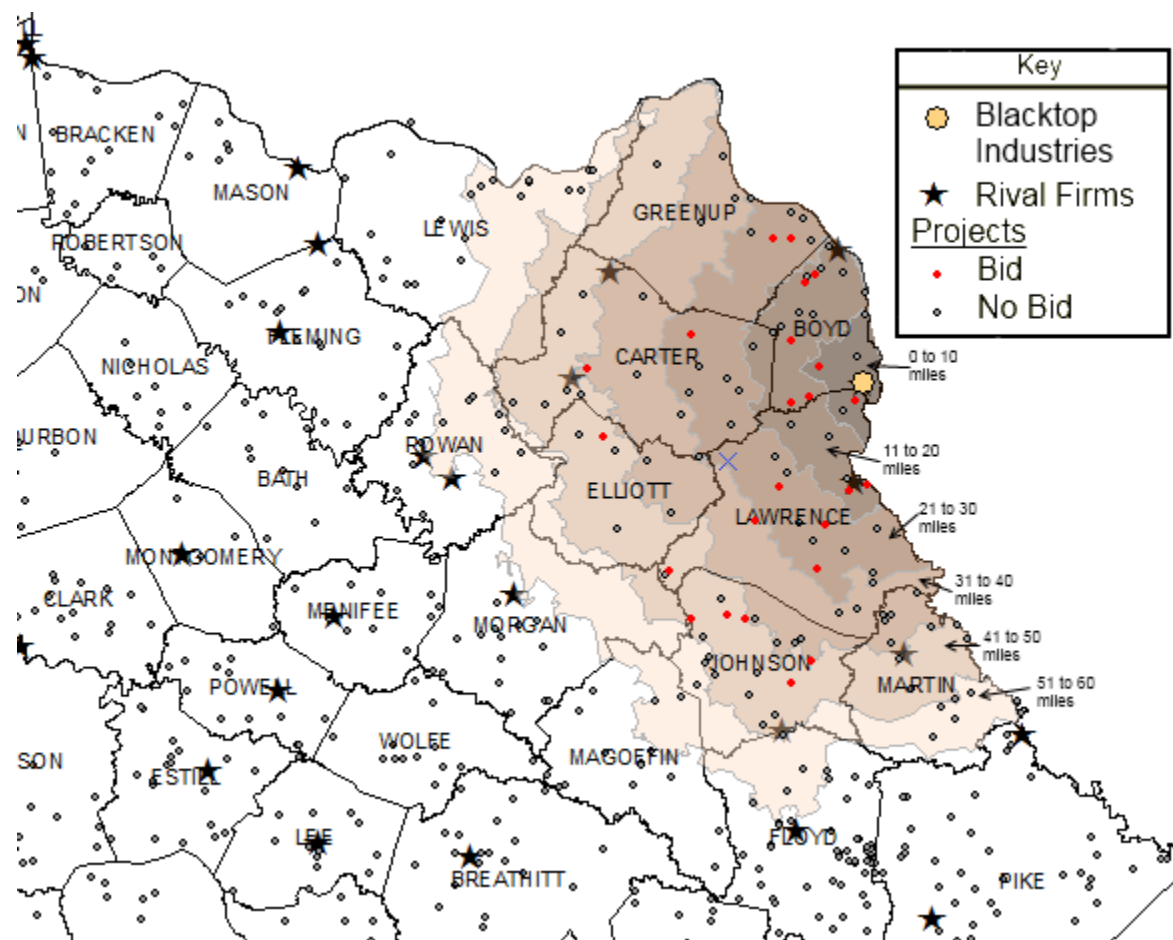
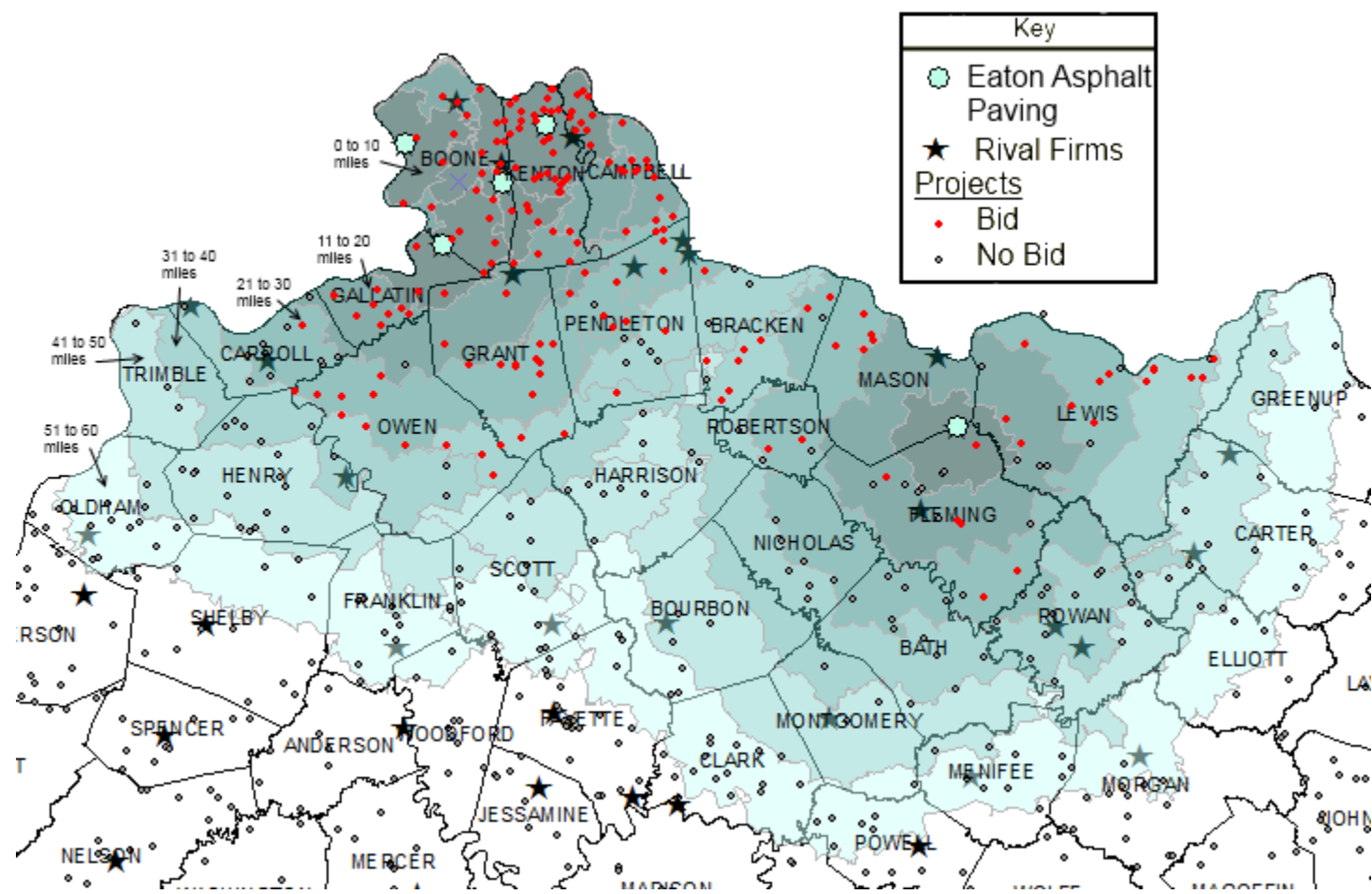


Figure 6.49: Eaton Asphalt Paving Service Area



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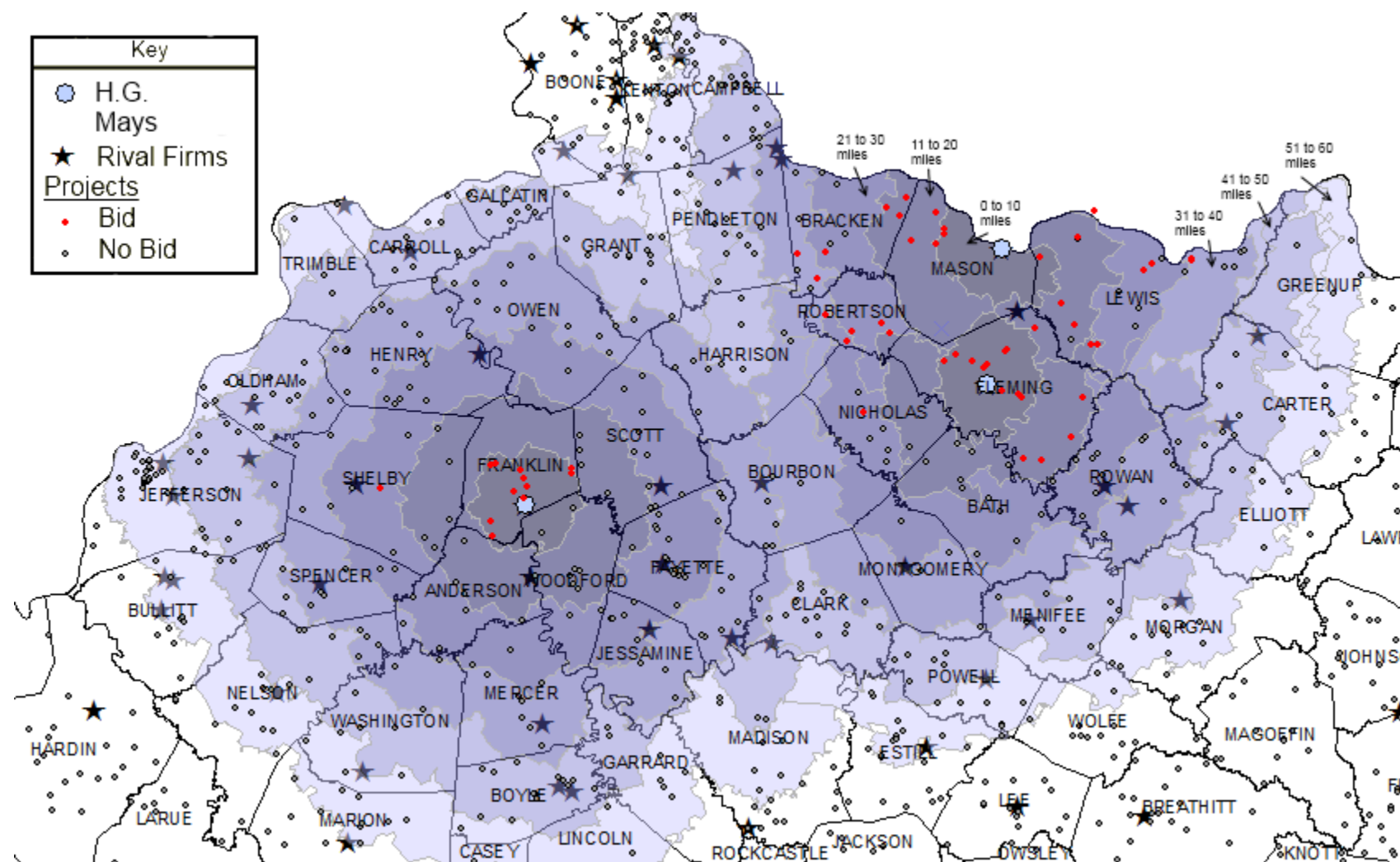


Figure 6.51: Hinkle Contracting Service Area

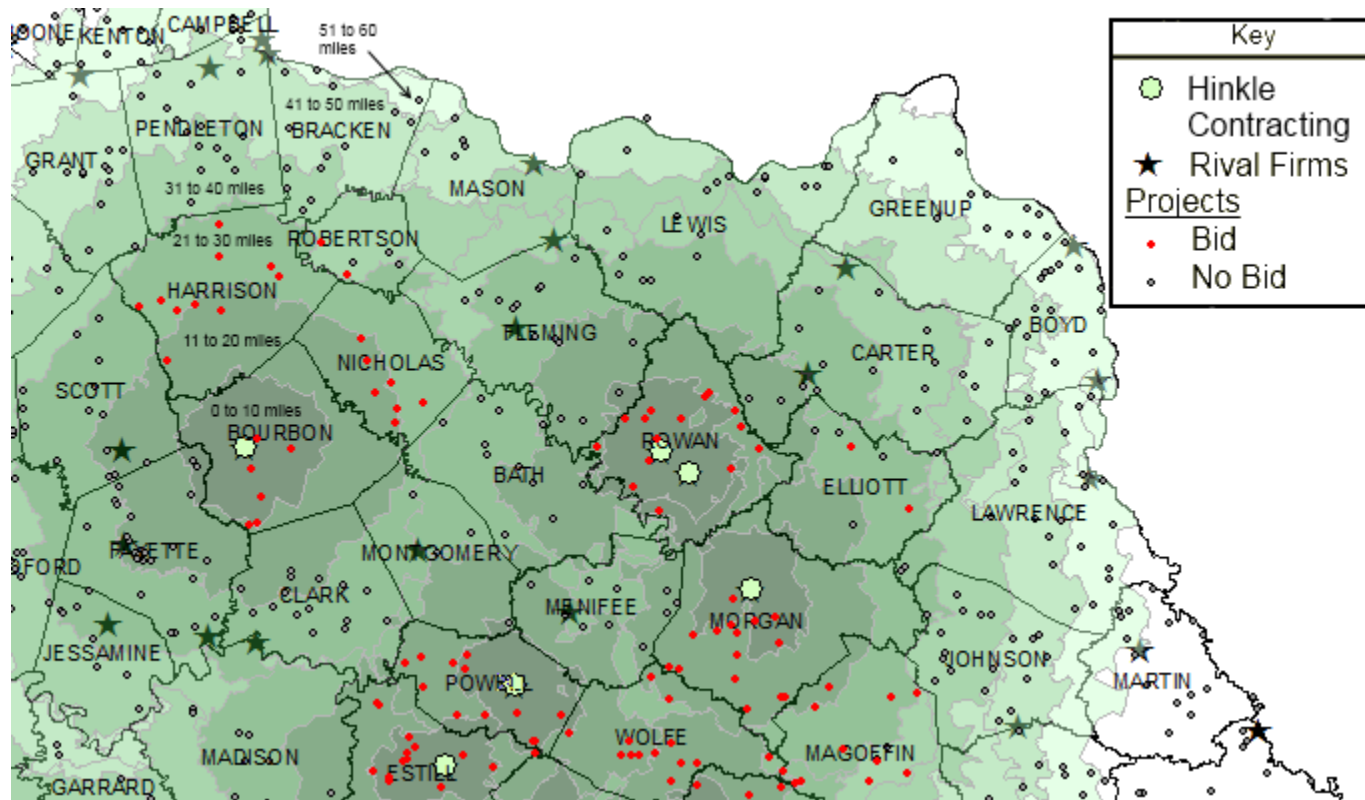
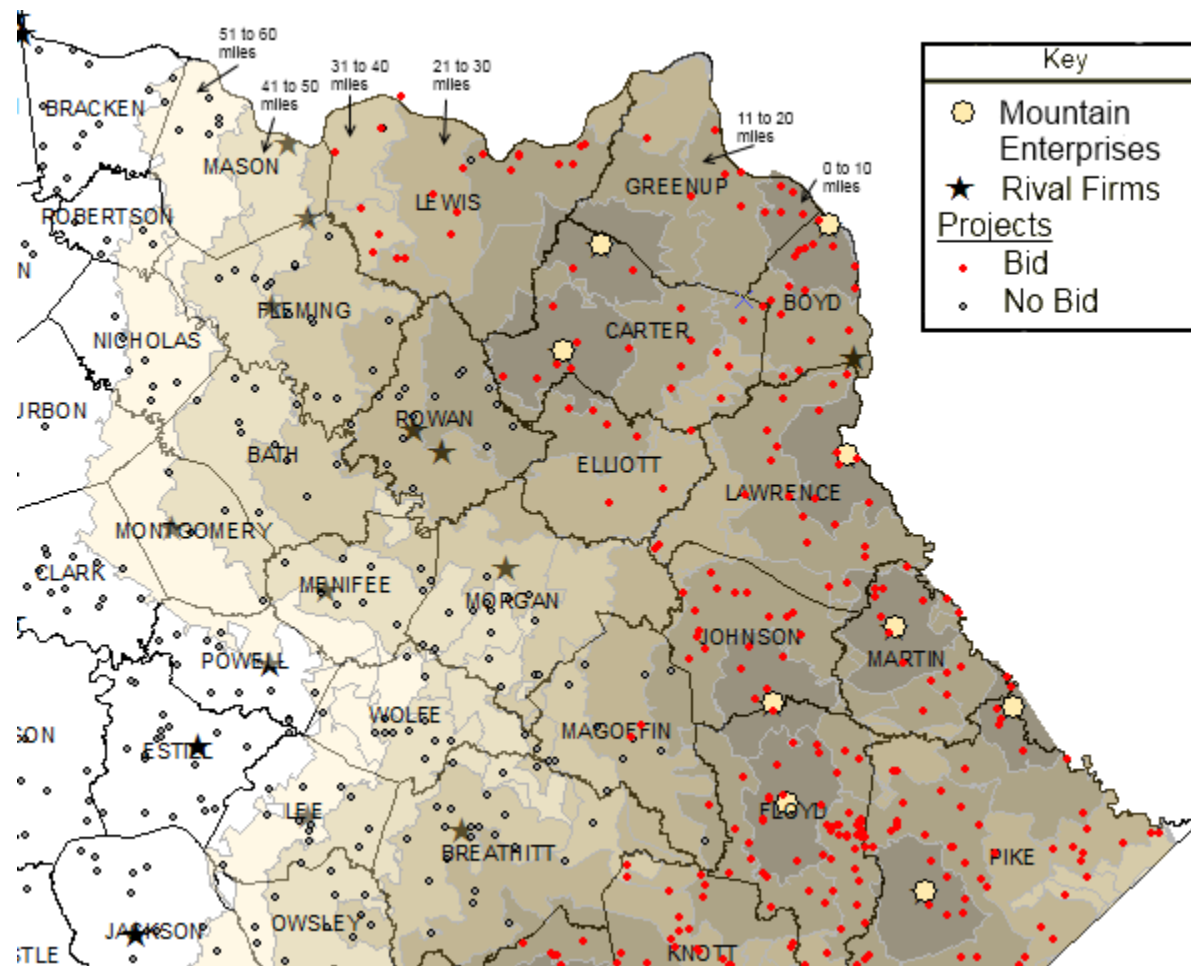


Figure 6.52: Mountain Enterprises Service Area



6.11 District 10 – Eastern Kentucky

District 10 consists of firms in the mountains of Eastern Kentucky (see Figure 6.53). There are three firms that have plants located in this district and that compete on projects: Hinkle Contracting, Mountain Enterprises, and The Walker Company. The Allen Company and Elmo Greer & Sons have plants in counties neighboring District 10. There is evidence of tacit collusion in every county. Two firms bid on projects in Magoffin and Powell Counties. In Magoffin County, Hinkle Contracting and Mountain Enterprises never bid on the same project. How this is accomplished is puzzling since the non-bidding firm does not purchase a bid proposal, and there is no clear geographic boundary that would divide the bids. In Powell County, The Walker Company bids on projects along with Hinkle Contracting but it does not put any downward pressure on the bids. This is also very puzzling. It has been shown repeatedly in district after district, that when there are two or more firms bidding the bid levels decline significantly from the single-bid level. There is no easy explanation for this and there is the possibility the firms are overtly colluding or engaging in some other form of tacit collusion. However, this cannot be substantiated and there is no evidence to support this claim, but it is a possibility. Since there is such odd bidding occurring on the competitive bids, it was decided to use the Kentucky competitive average of 14.28 percent below the engineer's estimate. This is being used because the District 10 average of multi-bid projects is 3.85 percent above the engineer's estimate which is higher than the single-bid average. It will give a better idea of the real impact of tacit collusion compared to an actual competitive environment. The result of this tacit collusion is that there are single-bid contracts are \$4,974,946.94 above the competitive level.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.40, Table 6.41, Table 6.42, and Table 6.43. A map for each firm follows the tables. The additional regression results found in Table 6.43 includes all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.11.1 Firms with Asphalt Plants in District 10

HINKLE CONTRACTING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Hinkle Contracting has five of their 11 asphalt plants located in District 10. Their primary competitors who have asphalt plants in this district are Mountain Enterprises and The Walker Company. Firms located in surrounding counties include The Allen Company (Madison) and Elmo Greer & Sons (Jackson and Clay). Hinkle Contracting bids on 107 projects in Kentucky and 58 of those projects are located in District 10. They were awarded 56 out of the 58 projects. The contracted value of all of the 58 projects was \$20,248,913.67. The average number of bidders on these projects was 1.05 bidders. There were 55 single-bid contracts that average 4.20 percent above the engineer's estimate. The remaining three bids with two or more bidders average 3.85 percent above the engineer's estimate. The factors that influence their bidding on projects will be highlighted in the next section.

FIRM BID FUNCTION

The bid function for Hinkle Contracting is in Table 6.42. The bid function for Hinkle Contracting was described in detail in District 7. Only the interesting points will be highlighted here. The distance variable is no longer significant when the additional variables are added into the regression. When the county variables are added, the variables for projects in the counties adjacent to where Hinkle Contracting has an asphalt plant are negative and significant. In the additional regression, specific firm and county variables were added and the results indicate that Hinkle Contracting is less likely to bid on projects in counties where The Allen Company, ATS Construction, Elmo Greer & Sons, H.G. Mays, Mountain Enterprises, and The Walker Company bid. They are less likely to bid on projects in Magoffin County. They actively bid on projects in Owsley and Wolfe Counties. More of their bidding behavior will be explored in the "Counties" section.

MOUNTAIN ENTERPRISES

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mountain Enterprises has one of their 13 asphalt plants located in District 10. Their primary competitor located in District 10 is Hinkle Contracting. Mountain Enterprises bid on 150 projects in Kentucky, and 14 of those projects are in District 10. They were awarded contracts on all 14 projects. The contracted value of the 14 projects was \$5,302,074.74 which averaged 4.93

percent above the engineer's estimate. The average number of bidders on these projects was 1.00 bidders.

FIRM BID FUNCTION

The results of the bid function for Mountain Enterprises can be found in Table 6.42. A more in-depth analysis of the bid function is in the District 9 section. I will only go over the highlights in this section. Distance is a major factor that determines whether they bid on a project. The county variables are negative and significant. They are less likely to bid on projects not in the county where they have an asphalt plant. Specific firm and county variables were added in Table 6.43 and they indicate they are less likely to bid on projects where Elmo Greer & Sons, H.G. Mays, Hinkle Contracting, and The Walker Company have asphalt plants. They are also less likely to bid on projects in Magoffin, Owsley, and Wolfe Counties. More of their bidding behavior will be explored in the "Counties" section.

THE WALKER COMPANY

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

The Walker Company of Kentucky has two asphalt plants in Kentucky with one of them located in Menifee County in District 10. Their primary competitor is Hinkle Contracting. They bid on 22 projects in Kentucky and nine of them are in District 10. They were awarded eight of the nine projects. The contracted value of these nine projects was \$2,582,224.15. The average number of bidders on these projects was 1.33 bidders. The six single-bid contracts averaged 0.40 percent above the engineer's estimate, while the three projects with two bidders average 3.85 percent above the engineer's estimate. This is an interesting phenomenon that has been seen in District 9 and District 10-the addition of two bidders does not drive the bid levels down. This may indicate that something else is going on to keep the bid levels high.

FIRM BID FUNCTION

The bid function for The Walker Company is in Table 6.42. An in-depth analysis of the bid function was discussed in the District 7 section. In this section, I will only present the most important points from that analysis. The bid proposal variables are driving the results. If a competitor purchases a bid proposal they are less likely to bid on a project. This is due to collinearity with the county variables. Consequently the county variables are not significant. When specific firm and county variables are added this result changes and they are more likely to bid on projects in counties where Hinkle Contracting has an asphalt plant. They are also less

likely to bid on projects in Magoffin, Owsley, and Wolfe Counties. Like the analysis for Road Builders, ATS Construction, and Lexington Quarry, the analysis for The Walker Company will focus on their bidding behavior as seen on their map. More of their bidding behavior will be explored in the “Counties” section.

6.11.2 Counties in District 10

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.43). The additional regressions for firms outside District 10 will be discussed and included in Table 6.43. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.42). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion. In a deviation from the analysis in previous districts, the single-bid contracts will be compared to the average of the multi-bid projects for Kentucky which is 14.28 percent below the engineer’s estimate. What is unique in District 10 is that the multi-bid projects actually average above the single-bid contracts with respect to the engineer’s estimate. The purpose is to measure the impact of tacit collusion on bid levels and how much they are elevated above the competitive level.

COUNTIES WITHOUT ASPHALT PLANTS

MAGOFFIN COUNTY

There are a total of eight projects in Magoffin County and Hinkle Contracting and Mountain Enterprises both bid on projects but never against each other. The total contracted value of these projects is \$4,277,899.09 which averages 4.96 percent above the engineer’s estimate. The average for competitive bids for District 10 projects is 4.16 percent above the engineer’s estimate (see Table 6.40). Only Hinkle Contracting and Mountain Enterprises are within reasonable distances to bid on the projects. What is odd about the bidding in this county is that the firms do not bid against each other. There is only one time where two firms purchase bid proposals for a project. Looking at Figure 6.54 and Figure 6.55 there is no clear geographic line of demarcation where the firms could be using to tacitly collude. Hinkle Contracting and

Mountain Enterprises have been bidding on projects in Magoffin since 1994 and the winner alternates from project to project but not in a clear pattern. What is even stranger is that according to the additional regressions, both firms are less likely to bid on projects in Magoffin County than the counties where they have their asphalt plants. The behavior is very suspicious and there is obviously some form of collusion occurring in Magoffin County which allows the firms to coordinate who bids on which project. It is clearly not being dictated by county boundaries and they both could be bidding on the projects. There has to be some mechanism in place that allows these firms to never bid against each other. One possibility is that the firms are able to calculate which firm can do a specific project at the lowest cost. If you are not the low cost firm, then you do not bid on the project. The result of this collusion is that bid levels are higher than the competitive level in Kentucky by \$823,067.78.

OWSLEY COUNTY

There are a total of six projects in Owsley County. The total contracted value of these projects is \$1,488,880.80. The projects' contracted value averages 2.36 percent above the engineer's estimate. Hinkle Contracting is the only firm that bids on projects in Owsley County. While Mountain Enterprises does bid on a project that appears to be on the border of Owsley and Perry County, most of the projects in Owsley County are more than 40 miles away from the asphalt plants in the mountains of Eastern Kentucky. On the other hand, Elmo Greer & Sons located in Jackson County is within a reasonable range to bid on the projects in Owsley County (see District 11). Kay & Kay Contracting is also another potential competitor since all the projects in Owsley County are within their 60 mile service area. According to the additional regressions, both Mountain Enterprises and Elmo Greer & Sons are less likely to bid on projects in Owsley County when other factors are controlled. In turn, Hinkle Contracting avoids bidding in these two firms' counties. There is evidence of tacit collusion. The impact of the tacit collusion between Hinkle Contracting and Elmo Greer & Sons and Mountain Enterprises is that bids are \$247,898.65 above the competitive level of Kentucky.

WOLFE COUNTY

There are a total of seven projects in Wolfe County. The total contracted value of these projects is \$4,491,761.65 which averages 0.78 percent above the engineer's estimate. Hinkle Contracting is the only firm that bids on the projects in Wolfe County. Other potential

competitors include Mountain Enterprises and The Walker Company. A variable for Wolfe County was added to the additional regressions for these two firms in Table 6.43. Both of these firms are less likely to bid on projects in Wolfe County holding the other factors, including distance, constant. In turn Hinkle Contracting is less likely to bid on projects in the counties where these firms have asphalt plants. The maps in Figure 6.54, Figure 6.55, and Figure 6.56 confirm it. The impact of the tacit collusion between Hinkle Contracting and Mountain Enterprises and The Walker Company is that bids are \$676,459.30 above the competitive level of Kentucky.

COUNTIES WITH ASPHALT PLANTS

BREATHITT, ESTILL, LEE, MORGAN, AND POWELL COUNTIES

Hinkle Contracting has asphalt plants in Breathitt, Estill, Lee, Morgan, and Powell Counties. There are a total of 40 projects in these counties with a total contracted value of \$11,401,008.72. The projects' contracted value averages 4.91 percent above the engineer's estimate with an average of 1.08 bidders per project. The only other firm that bids on projects in these counties is The Walker Company who bid actively in Powell County. Mountain Enterprises is another District 10 firm that could bid on projects in these counties. Firms located in other districts that are within reasonable distances to bid on projects in these counties include The Allen Company (District 7), ATS Construction (District 7), H.G. Mays (District 9), Elmo Greer & Sons (District 11), and Kay & Kay Contracting (District 11). Each county will be looked at on an individual basis.

In Breathitt County, there are 13 projects and only Hinkle Contracting bids on the projects. The projects have a contracted value of \$3,194,213.85 which averages 1.88 percent above the engineer's estimate. Mountain Enterprises and The Walker Company are the firms that could potentially bid on all the projects in Breathitt County. But neither firm bids on a single project. It is well established that Hinkle Contracting and Mountain Enterprises do not bid against each other. The Walker Company does avoid bidding in counties where Hinkle Contracting has their asphalt plants (see Figure 6.56). However, the projects in Breathitt County are on the edge of The Walker Company's service area. The tacit collusion between Hinkle Contracting and Mountain Enterprises leads to bids that are above the competitive level. Using

the Kentucky average for the competitive level of the bid, the bids turn out to be \$516,184.96 higher than the competitive level.

In Estill County, there are eight projects and Hinkle Contracting is the only firm that bids on the projects. The contractual value of the projects is \$2,256,295.60 and averages 1.82 percent above the engineer's estimate. The Allen Company and Elmo Greer & Sons have asphalt plants that border Estill County. ATS Construction and The Walker Company are two other firms that could potentially bid on all projects in Estill County. As has been documented previously, there is evidence of tacit collusion between Hinkle Contracting and The Allen Company and Elmo Greer & Sons. These firms do not bid in each other's counties. There is also quite a bit of evidence that The Walker Company does not bid on projects in most counties where Hinkle Contracting has an asphalt plant. There is no evidence that the other firm is coordinating bids with Hinkle Contracting in Estill County. This tacit collusion allows Hinkle Contracting to be the only bidder on the projects in Estill County, which are \$363,263.59 above for the competitive level for Kentucky.

In Lee County, there are six projects and Hinkle Contracting is the only firm that bids on all six of those projects. The contractual value of the six projects is \$2,036,557.45 and averages 3.19 percent above the engineer's estimate. Like Estill and Owsley Counties, Elmo Greer & Sons can reasonably bid on projects in Lee County along with The Allen Company, Kay & Kay Contracting, and The Walker Company. There is no evidence of coordination of bids between Hinkle Contracting and Kay & Kay Contracting. This leaves The Allen Company, Elmo Greer & Sons, and The Walker Company as tacitly colluding with Hinkle Contracting (see Table 6.43). There is evidence of tacit collusion. The projects in Lee County are \$355,786.59 above for the competitive level for Kentucky.

In Morgan County, there are seven projects and Hinkle Contracting is the only firm that bids on these projects. The contractual value of the seven projects is \$2,484,794.12 and averages 15.82 percent above the engineer's estimate. The potential bidders are Mountain Enterprises and The Walker Company. There is evidence of tacit collusion between Hinkle Contracting and Mountain Enterprises (see Table 6.43). There is also clear evidence that The Walker Company does not bid in Morgan County when they reasonably could (see Figure 6.56). Due to the tacit collusion, the projects in Morgan County are \$747,923.03 above the competitive level for Kentucky.

In Powell County, there six projects and Hinkle Contracting and The Walker Company are the only bidders. There are three projects where both of these firms bid on the projects; however the project averages 3.85 percent above the engineer's estimate. These are asphalt resurfacing projects. This is uncommon in Kentucky. One thing that is odd is that there is no competitive effect to the addition of The Walker Company and there is no clear indication how the bid levels are maintained in the presence of the additional firm. I looked back at the bidding history of asphalt paving in Powell County from 1994 through 2007. I found that the firms alternated winning asphalt projects. I could not find a consistent pattern to why each firm bid or did not bid on the projects. Unlike Magoffin County, the two firms do purchase bid proposals and/or bid on five out of the six projects. There are two bidders on three of the projects. As mentioned before, it is odd that even when the firms bid against each there is no competitive effect on bid levels. On one of the projects, the two bids are only \$467.90 apart. The other two bids are \$2464 and \$6340.60 apart. There is no consistent pattern on the price spacing between bids either. Other potential competitors include The Allen Company, ATS Construction, H.G. Mays, and Elmo Greer & Sons. Looking at the additional regressions in Table 6.43, there is evidence that The Allen Company, H.G. Mays and Elmo Greer & Sons avoid bidding against Hinkle Contracting and they return the favor. There is evidence of tacit collusion. If these firms actively bid in Powell County, it would drive down bid level. The projects in Powell County are \$183,377.38 above the competitive level for Kentucky.

MENIFEE COUNTY

There are a total of six projects in Menifee County, and The Walker Company has an asphalt plant in this county and is the only bidder on the projects. The total contracted value of these projects is \$2,090,088.15, which averages 0.40 percent above the engineer's estimate. As discussed in the last section, The Walker Company bids on projects in Powell County where Hinkle Contracting has an asphalt plant. However, Hinkle Contracting never bids on any projects where The Walker Company bids or has an asphalt plant outside of Powell County. Other potential competitors include The Allen Company (District 7), H.G. Mays (District 9), and Mountain Enterprises (District 9). These firms are less likely to bid on projects in Menifee County. According to Figure 6.56, The Walker Company avoids bidding on projects in the counties where these firms have asphalt plants. There is evidence of tacit collusion between The Walker Company and The Allen Company, H.G. Mays, Hinkle Contracting, and Mountain

Enterprises. This results in projects in Menifee County that are \$306,824.94 above the competitive level for Kentucky.

PERRY COUNTY

In Perry County, Mountain Enterprises has an asphalt plant. Hinkle Contracting and Elmo Greer & Sons are the two firms that could potentially bid on all projects in Perry County. There are 11 projects in Perry County, and the contracted value of these projects is \$3,891,438.15 and averages 5.10 percent above the engineer's estimate. Mountain Enterprises is the only firm that bids on these projects. As has been shown in previous counties there is evidence of tacit collusion between these three firms. Elmo Greer & Sons and Hinkle Contracting do not bid in Perry County and Mountain Enterprises does not bid in counties where they have asphalt plants. This tacit collusion results in bids that are \$754,160.71 above the competitive level for Kentucky.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 10 lacks in competition even when there are two or more firms bidding on a projects. At times the multi-bid projects have higher percentages above the engineer's estimate than the single-bid contracts. There is not a clear reason why this is occurring. It is possible that overt collusion is occurring or some other form of bid coordination, but there is no evidence to support this claim. There is evidence of tacit collusion in every county in District 10. Like the pattern that occurs in the rest of Kentucky, firms do not bid beyond the counties they regularly bid in. This leads to a high level of single-bid contracts and bid levels that are above the competitive level. Since the competitive bid levels were so odd, the average percentage over/under the engineer's estimate was used from all of Kentucky. The tacit collusion results in bids that are \$4,974,946.94 above the competitive bid level for Kentucky.

Table 6.40: Summary of Tacit Collusion for District 10 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Magoffin				8	\$ 4,277,899.09	4.96	Yes	Two Firms (A)	\$ 823,067.78
Owsley				6	\$ 1,488,880.80	2.37	Yes	Three Firms (B)	\$ 247,898.65
Wolfe				7	\$ 4,491,761.65	0.78	Yes	Three Firms (C)	\$ 676,459.30
TOTAL (WITHOUT ASPHALT PLANTS)				21	\$10,258,541.54	2.83			
WITH ASPHALT PLANTS									
Breathitt				13	\$ 3,194,213.85	1.88	Yes	Two Firms (A)	\$ 516,184.96
Estill				8	\$ 2,256,295.60	1.82	Yes	Four Firms (D)	\$ 363,263.59
Lee				6	\$ 2,036,557.45	3.19	Yes	Four Firms (D)	\$ 355,786.59
Menifee				6	\$ 2,090,088.15	0.40	Yes	Four Firms (E)	\$ 306,824.94
Morgan				7	\$ 2,484,794.12	15.82	Yes	Three Firms (F)	\$ 747,923.03
Perry				11	\$ 3,891,438.15	5.10	Yes	Three Firms (B)	\$ 754,160.71
Powell	3	\$ 491,156.00	3.85	3	\$ 937,991.70	5.27	Yes	Four Firms (G)	\$ 183,377.38
TOTAL (WITH ASPHALT PLANTS)	3	\$ 491,156.00	3.85	54	\$16,891,379.02	4.50			
TOTAL (DISTRICT 10)	3	\$ 491,156.00	3.85	75	\$27,149,920.56	4.03			\$4,974,946.94

(A) These firms include Hinkle Contracting and Mountain Enterprises

(B) These firms include Elmo Greer & Sons, Hinkle Contracting, and Mountain Enterprises

(C) These firms include Hinkle Contracting, Mountain Enterprises, and The Walker Company

(D) These firms include The Allen Company, Elmo Greer & Sons, Hinkle Contracting, and The Walker Company

(E) These firms include The Allen Company, H.G. Mays, Hinkle Contracting, and The Walker Company

(F) These firms include Hinkle Contracting, Mountain Enterprises, and The Walker Company

(G) These firms include The Allen Company, Elmo Greer & Sons, H.G. Mays and Hinkle Contracting

Table 6.41: Summary Statistics for District 10 Firms

VARIABLES	Hinkle Contracting		Mountain Enterprises		The Walker Company	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.202	0.402	0.538	0.499	0.0898	0.286
Distance Variables						
Distance (0 to 10 miles) [reference variable]	0.0810	0.273	0.122	0.328	0.0367	0.188
Distance (11 to 20 miles)	0.169	0.376	0.226	0.419	0.0857	0.281
Distance (21 to 30 miles)	0.169	0.376	0.183	0.387	0.127	0.333
Distance (31 to 40 miles)	0.224	0.417	0.176	0.381	0.245	0.431
Distance (41 to 50 miles)	0.188	0.391	0.147	0.355	0.237	0.426
Distance (51 to 60 miles)	0.168	0.374	0.147	0.355	0.269	0.445
Other Control Variables						
Jobs Under Contract	10.01	2.944	10.12	4.295	4.176	2.969
Engineer's Estimate	526,064	1.32E+06	504,063	9.44E+05	548,297	1.65E+06
Competitive Variables						
Number of Competitor Service Areas	8	3.767	4.179	2.507	9.351	3.538
Zero other competitive bid proposal purchased [reference variable]	0.177	0.382	0.452	0.499	0.0776	0.268
One other competitive bid proposal purchased	0.512	0.5	0.448	0.498	0.710	0.455
Two other competitive bid proposals purchased	0.267	0.443	0.0932	0.291	0.180	0.385
Three or more other competitive bid proposals purchased	0.0433	0.204	0.00717	0.0845	0.0327	0.178
County Variables						
Project in same county-no rival	0.136	0.343	0.348	0.477	0.0531	0.225
Project in same county-rival	0	-	0.0358	0.186	0	-
Project in adjacent county-no rival [reference variable]	0.294	0.456	0.265	0.442	0.310	0.464
Project in adjacent county-rival	0.571	0.495	0.351	0.478	0.637	0.482
Observations	531		285		245	

Table 6.42: Regression results for District 10 Firms

VARIABLES	Hinkle Contracting		Mountain Enterprises		The Walker Company	
	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	0.0177 (0.0352)	0.117*** (0.0447)	0.0358 (0.0363)	0.0452 (0.0302)	0.0343 (0.0286)	-0.00492 (0.00558)
Distance (21 to 30 miles)	-0.0850** (0.0401)	0.0781* (0.0432)	-0.0853* (0.0444)	-0.0297 (0.0377)	-0.0856 (0.0600)	-0.153 (0.0926)
Distance (31 to 40 miles)	-0.0904** (0.0448)	0.0721 (0.0441)	-0.336*** (0.0674)	-0.221*** (0.0566)	-0.0733 (0.0667)	-0.152 (0.105)
Distance (41 to 50 miles)	-0.108** (0.0465)	0.0517 (0.0432)	-0.482*** (0.0691)	-0.326*** (0.0582)	-0.0924 (0.0642)	-0.162 (0.0985)
Distance (51 to 60 miles)	-0.124*** (0.0475)	0.0399 (0.0431)	-0.463*** (0.0688)	-0.371*** (0.0606)	-0.0924 (0.0643)	-0.163 (0.0992)
Jobs Under Contract	-0.00162 (0.00210)	-0.00149 (0.00187)	-0.00698** (0.00298)	-0.00363 (0.00244)	0.00140 (0.00260)	0.00147 (0.00261)
Engineer's Estimate	-6.13e-09*** (2.21e-09)	-5.43e-09* (2.80e-09)	-2.04e-08 (1.51e-08)	-1.35e-08 (8.92e-09)	-2.01e-09 (1.88e-09)	-2.05e-09 (1.93e-09)
Potential Competitors	-0.00408** (0.00176)	-0.00166 (0.00144)	-0.0150*** (0.00528)	-0.0108* (0.00601)	-0.00157 (0.00108)	-0.00207 (0.00126)
One competitive bid proposal purchased	-0.881*** (0.0365)	-0.725*** (0.0591)	-0.491*** (0.0632)	-0.320*** (0.0574)	-0.907*** (0.0644)	-0.950*** (0.0464)
Two competitive bid proposals purchased	-0.906*** (0.0325)	-0.754*** (0.0555)	-0.548*** (0.0752)	-0.277*** (0.0789)	-0.909*** (0.0639)	-0.937*** (0.0520)
Three or more competitive bid proposals purchased	-0.888*** (0.0373)	-0.739*** (0.0585)	-0.761*** (0.137)	-0.439*** (0.113)	-0.906*** (0.0647)	-0.941*** (0.0505)
Project in same county-rival				0.0151 (0.0481)		
Project in adjacent county-no rival		-0.277*** (0.0693)		-0.0994*** (0.0333)		0.0786 (0.0561)
Project in adjacent county-rival		-0.356*** (0.0769)		-0.418*** (0.0525)		0.124 (0.0785)
Constant	1.059*** (0.0390)	1.057*** (0.0329)	1.163*** (0.0445)	1.108*** (0.0373)	1.009*** (0.00789)	1.014*** (0.0105)
Observations	531	531	279	279	245	245
R-squared	0.864	0.892	0.828	0.878	0.864	0.869

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.43: Additional regression results for District 10 firms and firms outside District 10

VARIABLES	Hinkle Contracting			Mountain Enterprises			The Walker Company		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival				0.0151 (0.0481)	0.0163 (0.0450)	0.0116 (0.0205)			
Project in adjacent county-no rival	-0.277*** (0.0693)	-0.244*** (0.0650)		-0.0994*** (0.0333)	-0.0742** (0.0344)		0.0786 (0.0561)	0.0776 (0.0580)	
Project in adjacent county-rival	-0.356*** (0.0769)		-0.683*** (0.111)	-0.418*** (0.0525)		-0.819*** (0.0627)	0.124 (0.0785)		0.00635 (0.00713)
Project in adjacent county-Allen Company		-0.341*** (0.0759)						0.101 (0.0748)	
Project in adjacent county-ATS Construction		-0.391*** (0.0843)						0.0850 (0.0859)	
Project in adjacent county-Elmo Greer & Sons		-0.316*** (0.0715)			-0.416*** (0.0586)			0.0928 (0.0659)	
Project in adjacent county-HG Mays		-0.318*** (0.0726)			-0.331*** (0.0773)			0.0856 (0.0752)	
Project in adjacent county-Hinkle Contracting					-0.464*** (0.0536)			0.167* (0.0981)	
Project in adjacent county-Kay & Kay Contracting		-0.0136 (0.0143)			0.121*** (0.0384)				
Project in adjacent county-Mountain Enterprises		-0.331*** (0.0742)						0.108 (0.0709)	
Project in adjacent county-Walker Company		-0.395*** (0.0832)			-0.223*** (0.0561)				
Project in Magoffin County			-0.229* (0.138)			-0.531*** (0.160)			-0.00242 (0.00958)
Project in Owsley County			-0.0178 (0.0198)			-0.835*** (0.0584)			0.00638 (0.00979)
Project in Wolfe County			-0.00994 (0.0179)			-0.840*** (0.0572)			-0.0510* (0.0273)
Constant	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	1.108*** (0.0373)	1.144*** (0.0383)	1.049*** (0.0214)	1.014*** (0.0105)	0.975*** (0.0227)	1.005*** (0.00721)
Observations	531	531	531	279	279	279	245	245	245
R-squared	0.892	0.893	0.942	0.878	0.886	0.967	0.869	0.874	0.888

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.43 (continued)

VARIABLES	The Allen Company			ATS Construction			HG Mays			Elmo Greer & Sons			Kay & Kay Contracting		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)				0.128 (0.0996)	0.252** (0.117)	0.218* (0.111)	0 (0)	-0 (0)	0.00677 (0.00842)			
Project in adjacent county-no rival	-0.177*** (0.0637)	-0.142** (0.0576)		-0.300 (0.198)	-0.290 (0.204)		-0.653*** (0.133)	-0.408*** (0.144)		-1*** (0)	-1*** (0)		-0.345** (0.159)	-0.950*** (0.194)	
Project in adjacent county-rival	-0.424*** (0.0671)		-1*** (0)	-0.314 (0.196)		-0.332* (0.198)	-0.729*** (0.133)		-0.374*** (0.128)	-1*** (0)		-0.922*** (0.0752)	-0.0593 (0.0762)		-0.0107 (0.0715)
Project in adjacent county-Allen Company					-0.311 (0.201)			-0.406*** (0.148)			-1*** (0)			-0.971*** (0.177)	
Project in adjacent county-ATS Construction		-0.678*** (0.0720)						-0.546*** (0.155)			-1*** (0)				
Project in adjacent county-Elmo Greer & Sons		-0.463*** (0.0766)			-0.284 (0.204)									-0.0469 (0.0570)	
Project in adjacent county-HG Mays		-0.244*** (0.0645)			-0.308 (0.201)										
Project in adjacent county-Hinkle Contracting		-0.385*** (0.0683)			-0.299 (0.203)			-0.541*** (0.141)			-1*** (0)			-0.681*** (0.235)	
Project in adjacent county-Kay & Kay Contracting		0.120*** (0.0378)													
Project in adjacent county-Mountain Enterprises								-0.525*** (0.137)			-1*** (0)			-0.925*** (0.177)	
Project in adjacent county-Walker Company		-0.392*** (0.0685)			-0.293 (0.202)			-0.516*** (0.141)			-1*** (0)				
Project in Magoffin County															
Project in Owsley County			-1*** (0)									-0.925*** (0.0728)			-0.757*** (0.204)
Project in Wolfe County			-1*** (0)			-0.351* (0.202)			-0.373*** (0.129)			-0.922*** (0.0752)			
Constant	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)	0.983*** (0.0286)	0.955*** (0.0549)	1.005*** (0.0150)	1.210*** (0.0723)	1.306*** (0.0974)	1.119*** (0.0535)	1*** (0)	1*** (0)	0.992*** (0.00895)	1.030*** (0.193)	0.699*** (0.207)	1.014*** (0.199)
Observations	336	336	336	283	283	283	373	373	373	277	277	277	62	62	62
R-squared	0.788	0.834	1.000	0.883	0.884	0.888	0.667	0.665	0.764	1.000	1.000	0.983	0.742	0.872	0.783

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.53: District 10

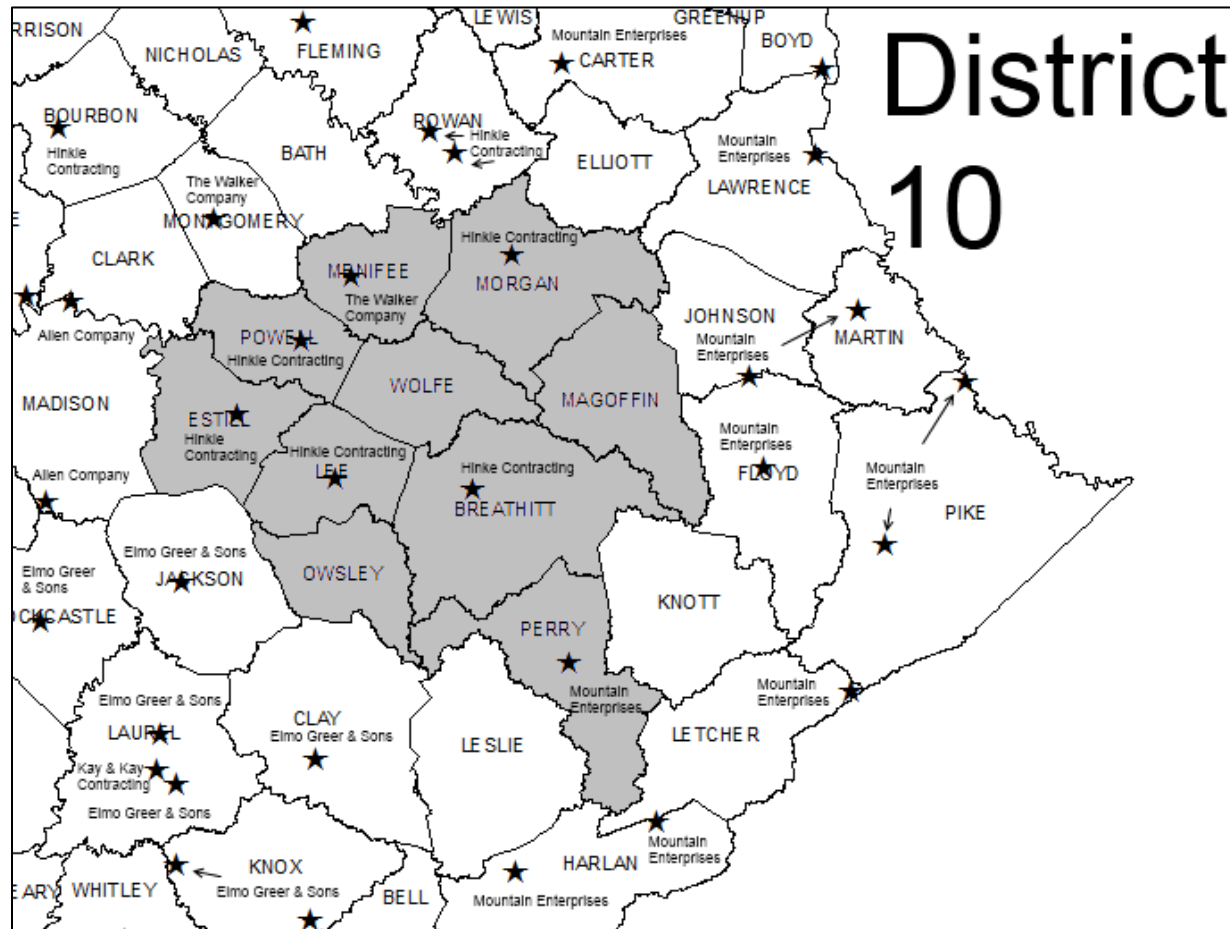


Figure 6.54: Hinkle Contracting Service Area

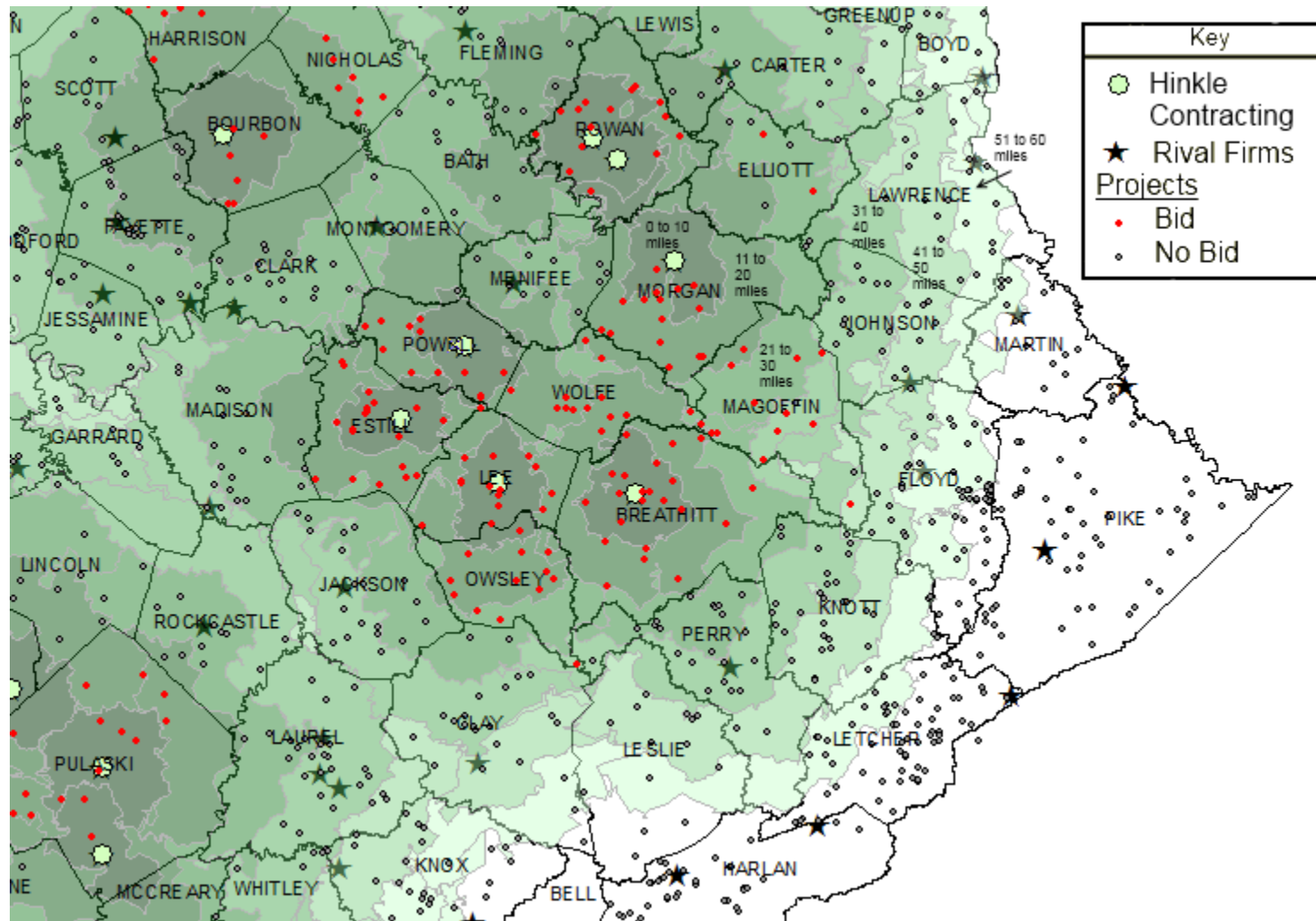


Figure 6.55: Mountain Enterprises Service Area

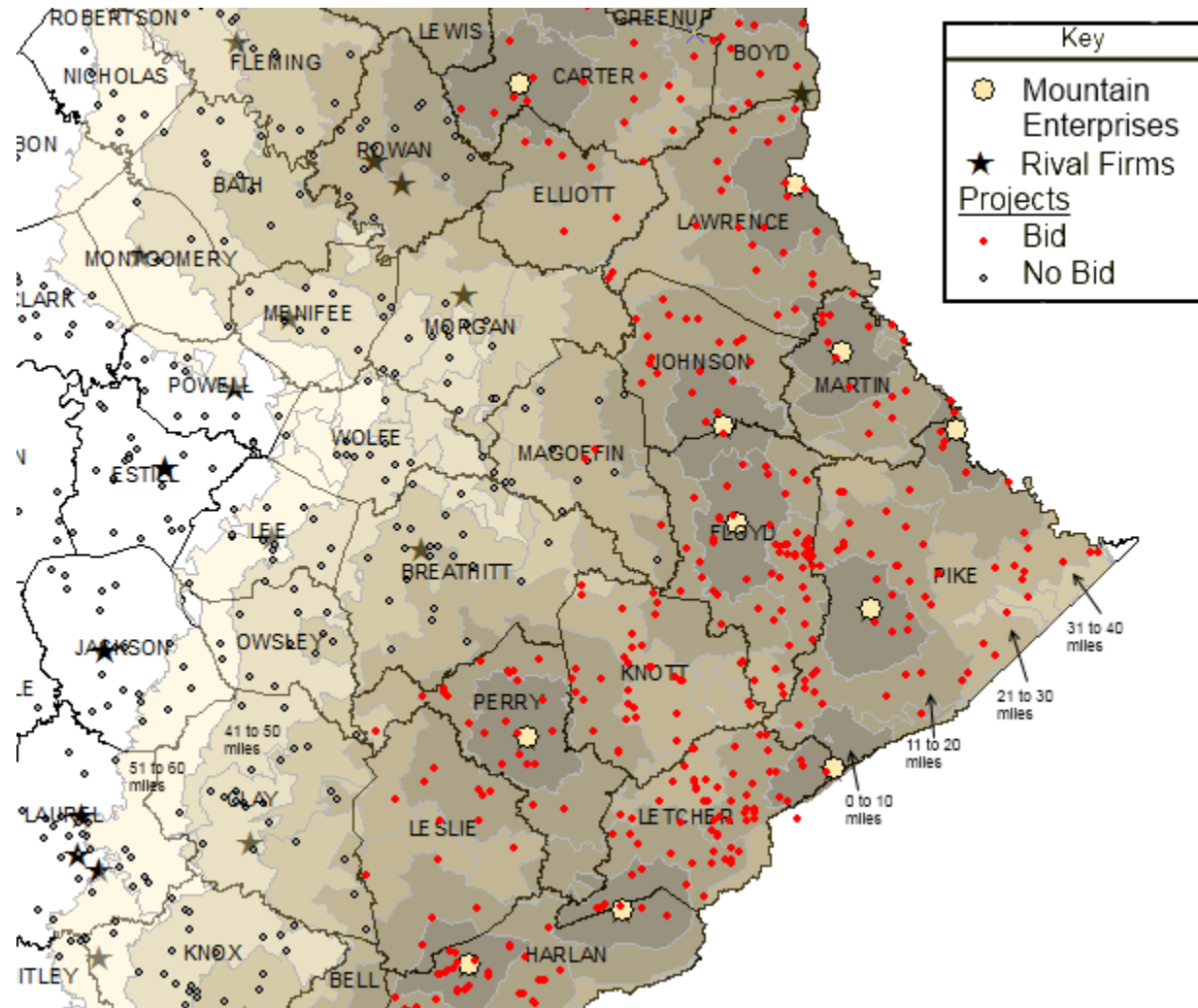
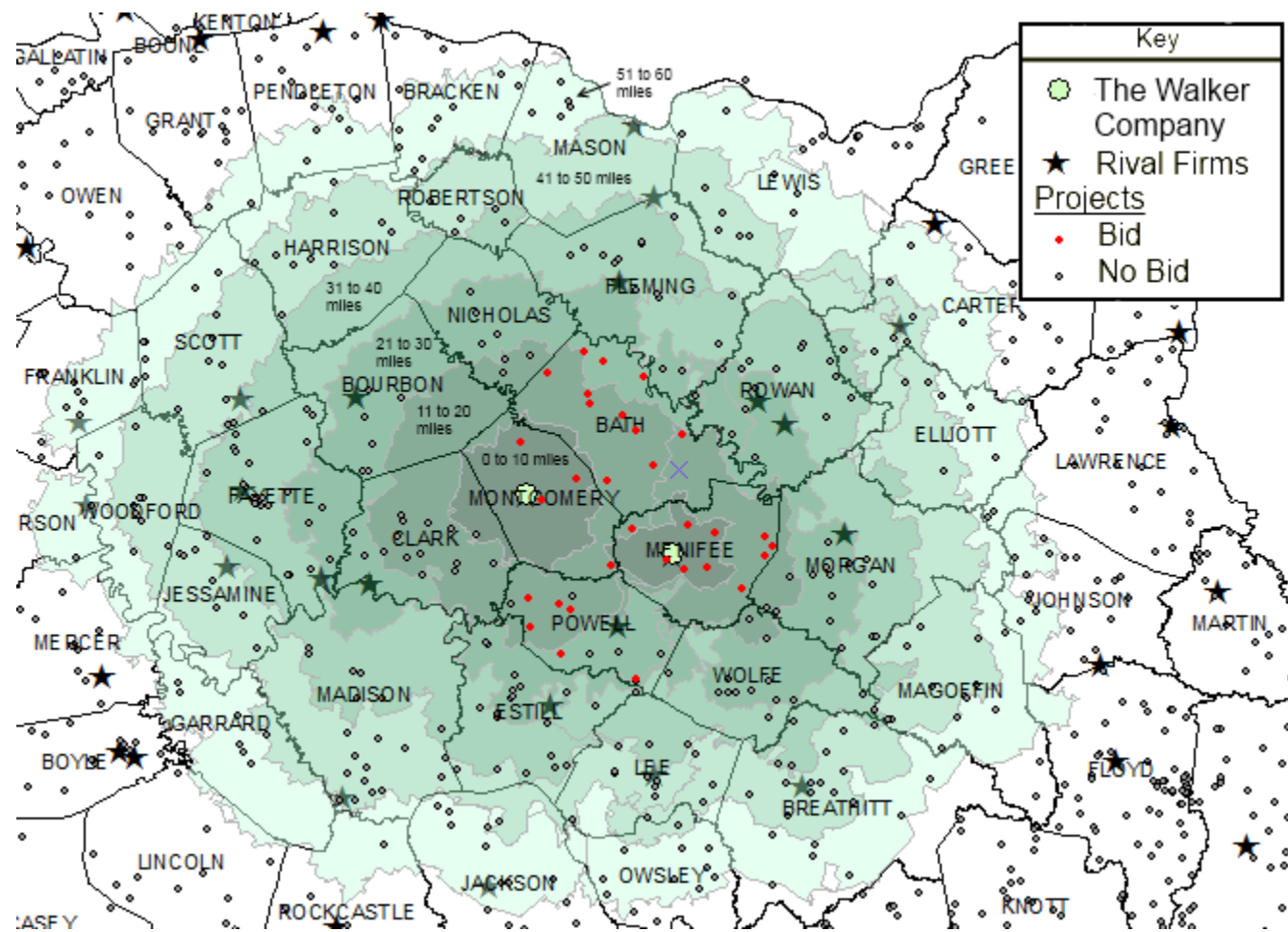


Figure 6.56: The Walker Company Service Area



6.12 District 11 – Southeastern Kentucky

District 11 consists of firms in the southeastern Kentucky near bordering Tennessee and Virginia (see Figure 6.57). There are three firms that have plants located in this district and that compete on projects: Elmo Greer & Sons, Kay & Kay Contracting, and Mountain Enterprises. The Allen Company and Hinkle Contracting have plants in counties that border District 11. There is evidence of tacit collusion among The Allen Company, Hinkle Contracting, Mountain Enterprises and Elmo Greer & Sons. These firms do not bid in each other's counties. Kay & Kay Contracting is an active bidder on projects in the district. Their bidding puts downward pressure on the bids. The result of this tacit collusion is that there are single-bid contracts which increase bids \$8,226,358.58 above the competitive level.

An analysis of the results for each firm is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.44, Table 6.45, Table 6.46, and Table 6.47. A map for the firms follows the tables. The additional regression results found in Table 6.47 includes all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.12.1 Firms with Asphalt Plants in District 11

ELMO GREER & SONS

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Elmo Greer & Sons has nine of their 10 plants located in District 11. Their primary competitors in this district are The Allen Company (District 7), Hinkle Contracting (District 10), Kay & Kay Contracting, and Mountain Enterprises. They bid on 69 projects in Kentucky and 61 of them are in District 11. They were awarded 58 of the 61 projects. The contracted value of the 61 projects was \$32,297,579.67. The average number of bidders on these projects was 1.44 bidders. There are 34 single-bid contracts where Elmo Greer & Sons was the only bidder. The 34 single-bid projects average 2.80 percent above the engineer's estimate while the 27 projects with more than one bidder average 20.42 percent below the engineer's estimate. Clearly, competition puts downward pressure on bid levels.

FIRM BID FUNCTION

The bid function for Elmo Greer & Sons can be found in Table 6.46. Without county variables, it indicates that once a project gets beyond 10 miles, the probability of Elmo Greer & Sons bidding on a project diminishes significantly. However, when the county variables are added the distance variables are not significant. This also happens with every other variable. They are almost all significant, but when the county variables are added they do not have a significant level of explanatory power. The reason is that the variables for “Project in adjacent county” perfectly explain why Elmo Greer & Sons bids on a project. This illustrates the fact that they stick to bidding to the counties where they have asphalt plants and do not bid beyond their county boundaries. The additional regressions in Table 6.47 shows they are less likely to bid on projects against The Allen Company, Hinkle Contracting and Mountain Enterprises. They also avoid bidding on projects in Leslie County. The question that will be examined in a later section is whether or not this is an indication they are tacitly colluding with competitors. More of their bidding behavior will be explored in the “Counties” section.

KAY & KAY CONTRACTING

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Kay & Kay Contracting have one plant located in District 11. Their primary competitor in this district is Elmo Greer & Sons. They also bid in Pulaski County where Hinkle Contracting has an asphalt plant. Kay & Kay Contracting bid on 33 projects in Kentucky. They were awarded three of the 33 projects. The contracted value of all of the 33 projects was \$19,101,929.60. The average number of bidders on these projects was 2.00 bids. The 33 projects average 20.14 percent below the engineer’s estimate. Kay & Kay Contracting only bids on projects where Elmo Greer & Sons is also a bidder.

FIRM BID FUNCTION

The bid function for Kay & Kay Contracting is in Table 6.46. Like Blacktop Industries in District 9, Kay & Kay Contracting did not start bidding on projects until 2006. I also restricted the analysis to the time frame that they were bidding on projects. This results in only 62 observations. It is important to combine this analysis with the map of their bidding behavior (see Figure 6.59). Without (A) and with (B) the county variables, it indicates that once a project gets beyond 40 miles, the probability of Kay & Kay Contracting bidding on a project diminishes significantly. The potential competitor variables are not significant. One of the county variables

is negative and significant. It is when a project is in an adjacent county without a rival firm. Looking at their map, they do not bid in counties such as Owsley County where no firm has an asphalt plant. This reflects the fact that Kay & Kay Contracting bids on projects in counties where Elmo Greer & Sons has their asphalt plants. When specific firms are added, there is evidence they avoid bidding against The Allen Company, Hinkle Contracting, and Mountain Enterprises. They also avoid bidding in Leslie County. However, this is not an indication that Kay & Kay Contracting is tacitly colluding with these firms. They also cannot reach all of the projects in the counties where these firms have asphalt plants (i.e. Madison County, Estill County, Harlan County, etc). The one exception is Pulaski County and they do bid on projects in this county. This is one of the few competitive firms. Their target is bidding against Elmo Greer & Sons and so they do not bid against these other firms. More of their bidding behavior will be explored in the "Counties" section.

MOUNTAIN ENTERPRISES

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mountain Enterprises has two of their 13 asphalt plants located in District 11. Their primary competitor located in District 11 is Elmo Greer & Sons. Mountain Enterprises bid on 150 projects in Kentucky, and 21 of those projects are in District 11. They were awarded contracts on all 21 projects they bid on in District 11. All of the 21 projects only had one bidder-Mountain Enterprises. The contracted value of the 21 projects was \$17,950,430.17, which averages 6.07 percent above the engineer's estimate.

FIRM BID FUNCTION

The results of the bid function for Mountain Enterprises can be found in Table 6.46. A more in-depth analysis of the bid function is in the District 9 section. I will only go over the highlights in this section. Distance is a major factor that impacts their bidding behavior. The county variables significantly impacted whether or not they bid on a project. They are less likely to bid on a project in an adjacent county if a firm has an asphalt plant as opposed to a project located in a county where they have their asphalt plants. They are less likely to bid if Elmo Greer & Sons and Hinkle Contracting have asphalt plants in the county. They also bid on projects in Leslie County. More of their bidding behavior will be explored in the "Counties" section.

6.12.2 *Counties in District 11*

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.47). The additional regressions for firms outside District 11 will be discussed and included in Table 6.47. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.46). However, these variables were not displayed due to lack of space. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

LESLIE COUNTY

There are a total of 10 projects in Leslie County and only one bidder, Mountain Enterprises, bids on the projects. The total contracted value of these projects is \$10,102,933.72. The projects' contracted value averages 5.74 percent above the engineer's estimate. The average for competitive bids for District 11 projects is 20.42 percent below the engineer's estimate (see Table 6.44). Elmo Greer & Sons is the one firm that can bid on all of the projects in Leslie County. Kay & Kay Contracting can bid on some projects but not all of them. According to the additional regression results in Table 6.47, the coefficient on Leslie County is negative and significant for Elmo Greer & Sons which means they avoid bidding in Leslie County. Mountain Enterprises does not bid against Elmo Greer & Sons. There is one project on the Leslie County side of the border between Clay and Leslie County (see Figure 6.58).¹²⁷ Elmo Greer & Sons does not bid on the project but Mountain Enterprises does (see Figure 6.60). These two firms are clearly using county boundaries to determine whether they bid on a project and they do not cross over and bid in the other firm's county. There is evidence of tacit collusion between Elmo Greer & Sons and Mountain Enterprises. This coordination of bids results in bid levels that are

¹²⁷ Project 52230 starts at the Leslie-Clay County line and does the portion of the Red Bird River Road (KY 66) in Leslie County. Both projects are in Leslie County and Mountain Enterprises is the only firm that bids on both projects.

\$2,642,927.46 above the competitive level for District 11.

COUNTIES WITH ASPHALT PLANTS

BELL, CLAY, JACKSON, KNOX, LAUREL, AND WHITLEY COUNTIES

There are a total of 61 projects in Bell, Clay, Jackson, Knox, Laurel, and Whitley Counties where Elmo Greer & Sons has their asphalt plants. Kay & Kay Contracting have an asphalt plant in Laurel County. The total contracted value of these projects is \$32,297,579.67, which averages 7.45 percent below the engineer's estimate. Thirty-four of these projects only have one bidder. What is interesting to note is that Kay & Kay Contracting does not actively bid in this area until the latter half of 2006 and into 2007. For this reason, in 2005 and part of 2006 Elmo Greer & Sons is the only bidder. In some cases other firms could have reasonably bid on the projects, and in other cases they are the only firm that could reasonably bid on the projects. Each county will be analyzed individually in the following paragraphs.

In Bell County, there are eight projects that have a contracted value of \$4,614,372.01. There are six projects that only have one bidder, Elmo Greer & Sons. These projects average 0.13 percent above the engineer's estimate. The other two projects with two bidders average 20.45 percent below the engineer's estimate. When Kay & Kay Contracting bids on projects it drives the bid levels down dramatically. Mountain Enterprises is the other firm that can reasonably bid on projects in Bell County because they have plants in Harlan County. Looking at the additional regressions, Mountain Enterprises is less likely to bid on a project in a county where Elmo Greer & Sons has an asphalt plant and Elmo Greer & Sons does the same. As in Leslie County, there are projects near the border of Bell and Harlan Counties (see Figure 6.58 and Figure 6.60). Elmo Greer & Sons bids on the projects in Bell County and Mountain Enterprises bids on projects in Harlan County. There is evidence of tacit collusion between these two firms. If Mountain Enterprises bid actively on projects in Bell County it could drive bid levels down. The impact of this tacit collusion is that the single-bids in Bell County are \$831,969.03 above the competitive level of District 11.

The 11 projects in Clay County have a contracted value of \$4,121,927.50. Elmo Greer & Sons is the only bidder on seven of the bids, and these bids average 5.42 percent above the engineer's estimate. The other four projects have two bidders and average 21.67 percent below the engineer's estimate. Kay & Kay Contracting is the other bidder. Mountain Enterprises is a

potential bidder on projects in Clay County. As documented in Leslie County, there is tacit collusion between Mountain Enterprises and Elmo Greer & Sons. If Mountain Enterprises did bid on projects in Clay County, the threat of their bidding could force bid levels down. The impact of this tacit collusion is that the single-bids in Clay County are \$754,770.77 above the competitive level of District 11.

There are nine projects in Jackson County with a contracted value of \$3,269,572.71. Elmo Greer & Sons is the lone bidder on five of the bids, and these bids average 3.60 percent above the engineer's estimate. The other four projects have two bidders and average 16.67 percent below the engineer's estimate. Kay & Kay Contracting is the other bidder. The Allen Company has asphalt plants in Madison County and Hinkle Contracting has asphalt plants in Estill and Lee County. As has been documented for those counties, there is tacit collusion occurring among Elmo Greer & Sons, The Allen Company, and Hinkle Contracting (see Table 6.47). They do not bid in each other's counties. If these firms bid actively in Jackson County it could drive bid levels down. The impact of this tacit collusion is that the single-bid contracts in Jackson County are \$540,705.50 above the competitive level of District 11.

There are 12 projects in Knox County with a contracted value of \$2,958,602.72. Elmo Greer & Sons is the only bidder on seven of the bids, and these bids average 1.31 percent above the engineer's estimate. The other five projects have two bidders and average 20.69 percent below the engineer's estimate. Kay & Kay Contracting is the other bidder. Mountain Enterprises is within a reasonable range to bid on these projects, but they do not bid on any of the projects (see Figure 6.60). There is evidence of tacit collusion between these firms (see Table 6.47). The impact of this tacit collusion is that the single-bid contracts in Knox County are \$432,207.55 above the competitive level of District 11.

The 11 projects in Laurel County have a contracted value of \$4,052,448.00. Five of the bids have only one bidder, Elmo Greer & Sons, which average 2.95 percent above the engineer's estimate. The other six projects have two bidders and average 25.16 percent below the engineer's estimate. Kay & Kay Contracting is the other bidder. Hinkle Contracting has asphalt plants in neighboring Pulaski County (see District 8). The Allen Company is also a potential bidder in Madison County. These three firms tacitly collude by not bidding in each other's counties (see Table 6.47). If Hinkle Contracting and The Allen Company did bid on the projects

then it would drive bid levels lower. The impact of this tacit collusion is that the single-bid contracts in Laurel County are \$608,686.16 above the competitive level of District 11.

There are 10 projects in Whitley County with a contracted value of \$13,280,656.73. Four of the bids have only one bidder, Elmo Greer & Sons. The single-bid contracts average 3.66 percent above the engineer's estimate. The other six projects have two bidders and average 17.10 percent below the engineer's estimate. Kay & Kay Contracting is the other bidder. Hinkle Contracting is a potential bidder and can bid on projects in Whitley County. They do not, and it has been established that these two firms tacitly collude by refusing to bid in each other's counties (see Table 6.47). The impact of this tacit collusion is that the single-bid contracts in Whitley County are \$312,747.80 above the competitive level of District 11.

HARLAN COUNTY

There are a total of 11 projects in Harlan County. The total contracted value of these projects is \$7,847,496.45. The projects' contracted value averages 6.37 percent above the engineer's estimate. As shown in the Bell County section, Mountain Enterprises and Elmo Greer & Sons are tacitly colluding. They do not bid on projects in the other firms counties (see Figure 6.58 and Figure 6.60). If these firms actively bid against each other then bid levels would be lower. The impact of this tacit collusion is that the single-bids in Harlan County are \$2,102,344.30 above the competitive level of District 11.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 11 is that Kay & Kay Contracting actively bids against Elmo Greer & Sons. This puts downward pressure on the bids. Elmo Greer & Sons tacitly colludes with The Allen Company, Hinkle Contracting, and Mountain Enterprises by not bidding in the counties they have asphalt plants or where they bid. These firms do the same in return. This increases bid levels above the competitive level. This tacit collusion results in bids that are \$8,226,358.58 above the competitive bid level for District 11.

Table 6.44: Summary of Tacit Collusion for District 11 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Leslie				10	\$10,102,933.72	5.74	Yes	Two Firms (A)	\$ 2,642,927.46
TOTAL (WITHOUT ASPHALT PLANTS)				10	\$10,102,933.72	5.74			
WITH ASPHALT PLANTS									
Bell	2	\$ 565,860.90	-20.45	6	\$ 4,048,511.11	0.13	Yes	Two Firms (A)	\$ 831,969.03
Clay	4	\$ 1,200,988.00	-21.67	7	\$ 2,920,939.50	5.42	Yes	Two Firms (A)	\$ 754,770.77
Harlan				11	\$ 7,847,496.45	6.37	Yes	Two Firms (A)	\$ 2,102,344.30
Jackson	4	\$ 1,018,509.00	-16.67	5	\$ 2,251,063.71	3.60	Yes	Three Firms (B)	\$ 540,705.50
Knox	5	\$ 969,612.60	-20.69	7	\$ 1,988,990.12	1.31	Yes	Two Firms (A)	\$ 432,207.55
Laurel	6	\$ 1,447,885.90	-25.16	5	\$ 2,604,562.10	2.95	Yes	Three Firms (B)	\$ 608,686.16
Whitley	6	\$ 11,981,870.20	-17.10	4	\$ 1,298,786.53	3.66	Yes	Two Firms (C)	\$ 312,747.80
TOTAL (WITH ASPHALT PLANTS)	27	\$ 17,184,726.60	-20.42	45	\$22,960,349.52	3.67			
TOTAL (DISTRICT 11)	27	\$ 17,184,726.60	-20.42	55	\$33,063,283.24	4.05			\$ 8,226,358.58

(A) These firms include Elmo Greer & Sons and Mountain Enterprises

(B) These firms include The Allen Company, Elmo Greer & Sons, and Hinkle Contracting

(C) These firms include Elmo Greer & Sons and Hinkle Contracting

Table 6.45: Summary Statistics for District 11 Firms

VARIABLES	Elmo Greer & Sons		Kay & Kay Contracting		Mountain Enterprises	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.249	0.433	0.532	0.503	0.538	0.499
Distance Variables						
Distance (0 to 10 miles) [reference variable]	0.112	0.316	0.0806	0.275	0.122	0.328
Distance (11 to 20 miles)	0.141	0.348	0.0645	0.248	0.226	0.419
Distance (21 to 30 miles)	0.101	0.302	0.161	0.371	0.183	0.387
Distance (31 to 40 miles)	0.199	0.4	0.194	0.398	0.176	0.381
Distance (41 to 50 miles)	0.191	0.394	0.129	0.338	0.147	0.355
Distance (51 to 60 miles)	0.256	0.437	0.371	0.487	0.147	0.355
Other Control Variables						
Jobs Under Contract	11.51	2.959	4.323	2.014	10.12	4.295
Engineer's Estimate	578,252	1.63E+06	664,818	1.73E+06	504,063	9.44E+05
Competitive Variables						
Number of Competitor Service Areas	7.578	3.653	6.726	3.058	4.179	2.507
Zero other competitive bid proposal purchased [reference variable]	0.134	0.341	0	-	0.452	0.499
One other competitive bid proposal purchased	0.697	0.46	0.903	0.298	0.448	0.498
Two other competitive bid proposals purchased	0.162	0.37	0.0968	0.298	0.0932	0.291
Three or more other competitive bid proposals purchased	0.00722	0.0848	0	-	0.00717	0.0845
County Variables						
Project in same county-no rival	0.209	0.408	0	-	0.348	0.477
Project in same county-rival	0.0397	0.196	0.0968	0.298	0.0358	0.186
Project in adjacent county-no rival [reference variable]	0.231	0.422	0.194	0.398	0.265	0.442
Project in adjacent county-rival	0.520	0.501	0.710	0.458	0.351	0.478
Observations	277		62		285	

Table 6.46: Regression results for District 11 Firms

VARIABLES	Elmo Greer & Sons		Kay & Kay Contracting		Mountain Enterprises	
	(A)	(B)	(A)	(B)	(A)	(B)
Distance (11 to 20 miles)	-0.151*** (0.0530)	-0*** (0)	-0.0500 (0.0493)	-0.0156 (0.0413)	0.0358 (0.0363)	0.0452 (0.0302)
Distance (21 to 30 miles)	-0.573*** (0.0868)	-0*** (0)	-0.102 (0.0999)	-0.0524 (0.109)	-0.0853* (0.0444)	-0.0297 (0.0377)
Distance (31 to 40 miles)	-0.782*** (0.0492)	-0*** (0)	-0.0807 (0.0910)	-0.000601 (0.0876)	-0.336*** (0.0674)	-0.221*** (0.0566)
Distance (41 to 50 miles)	-0.807*** (0.0472)	-0*** (0)	-0.682*** (0.179)	-0.532** (0.212)	-0.482*** (0.0691)	-0.326*** (0.0582)
Distance (51 to 60 miles)	-0.775*** (0.0493)	-0*** (0)	-0.815*** (0.115)	-0.680*** (0.140)	-0.463*** (0.0688)	-0.371*** (0.0606)
Jobs Under Contract	0.0118*** (0.00347)	0*** (0)	0.0198 (0.0194)	0.0275 (0.0199)	-0.00698** (0.00298)	-0.00363 (0.00244)
Engineer's Estimate	3.73e-10 (3.07e-09)	0 (0)	-1.04e-09 (9.71e-09)	5.17e-09 (7.23e-09)	-2.04e-08 (1.51e-08)	-1.35e-08 (8.92e-09)
Potential Competitors	-0.0151*** (0.00356)	-0*** (0)	-0.0312 (0.0187)	-0.0288 (0.0193)	-0.0150*** (0.00528)	-0.0108* (0.00601)
One competitive bid proposal purchased	-0.289*** (0.0644)	-0*** (0)	0.0711 (0.113)	0.0139 (0.145)	-0.491*** (0.0632)	-0.320*** (0.0574)
Two competitive bid proposals purchased	-0.304*** (0.0683)	-0*** (0)			-0.548*** (0.0752)	-0.277*** (0.0789)
Three or more competitive bid proposals purchased	-0.562*** (0.201)	-0 (0)			-0.761*** (0.137)	-0.439*** (0.113)
Project in same county-rival		0 (0)				0.0151 (0.0481)
Project in adjacent county-no rival		-1*** (0)		-0.345** (0.159)		-0.0994*** (0.0333)
Project in adjacent county-rival		-1*** (0)		-0.0593 (0.0762)		-0.418*** (0.0525)
Constant	1.070*** (0.0457)	1*** (0)	1.018*** (0.165)	1.030*** (0.193)	1.163*** (0.0445)	1.108*** (0.0373)
Observations	277	277	62	62	279	279
R-squared	0.831	1.000	0.702	0.742	0.828	0.878

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.47: Additional regression results for District 11 firms and firms outside District 11

VARIABLES	Elmo Greer & Sons			Kay & Kay Contracting			Mountain Enterprises		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0 (0)	-0 (0)	0.00677 (0.00842)				0.0151 (0.0481)	0.0163 (0.0450)	0.0116 (0.0205)
Project in adjacent county-no rival	-1*** (0)	-1*** (0)		-0.345** (0.159)	-0.950*** (0.194)		-0.0994*** (0.0333)	-0.0742** (0.0344)	
Project in adjacent county-rival	-1*** (0)		-0.922*** (0.0752)	-0.0593 (0.0762)		-0.0107 (0.0715)	-0.418*** (0.0525)		-0.819*** (0.0627)
Project in adjacent county-Allen Company		-1*** (0)			-0.971*** (0.177)				
Project in adjacent county-Elmo Greer & Sons					-0.0469 (0.0570)			-0.416*** (0.0586)	
Project in adjacent county-Hinkle Contracting		-1*** (0)			-0.681*** (0.235)			-0.464*** (0.0536)	
Project in adjacent county-Kay & Kay Contracting								0.121*** (0.0384)	
Project in adjacent county-Mountain Enterprises		-1*** (0)			-0.925*** (0.177)				
Project in Leslie County			-0.927*** (0.0709)			-0.345** (0.168)			-0.000129 (0.0131)
Constant	1*** (0)	1*** (0)	0.992*** (0.00895)	1.030*** (0.193)	0.699*** (0.207)	1.014*** (0.199)	1.108*** (0.0373)	1.144*** (0.0383)	1.049*** (0.0214)
Observations	277	277	277	62	62	62	279	279	279
R-squared	1.000	1.000	0.983	0.742	0.872	0.783	0.878	0.886	0.967

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.47 (continued)

VARIABLES	The Allen Company			Hinkle Contracting		
	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival	0.241** (0.0959)	0.204** (0.0840)	-0*** (0)			
Project in adjacent county-no rival	-0.177*** (0.0637)	-0.142** (0.0576)		-0.277*** (0.0693)	-0.244*** (0.0650)	
Project in adjacent county-rival	-0.424*** (0.0671)		-1*** (0)	-0.356*** (0.0769)		-0.683*** (0.111)
Project in adjacent county-Allen Company					-0.341*** (0.0759)	
Project in adjacent county-Elmo Greer & Sons		-0.463*** (0.0766)			-0.316*** (0.0715)	
Project in adjacent county-Hinkle Contracting		-0.385*** (0.0683)				
Project in adjacent county-Kay & Kay Contracting		0.120*** (0.0378)			-0.0136 (0.0143)	
Project in adjacent county-Mountain Enterprises					-0.331*** (0.0742)	
Project in Leslie County						-0.690*** (0.112)
Constant	1.289*** (0.0724)	1.322*** (0.0928)	1*** (0)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)
Observations	336	336	336	531	531	531
R-squared	0.788	0.834	1.000	0.892	0.893	0.942

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

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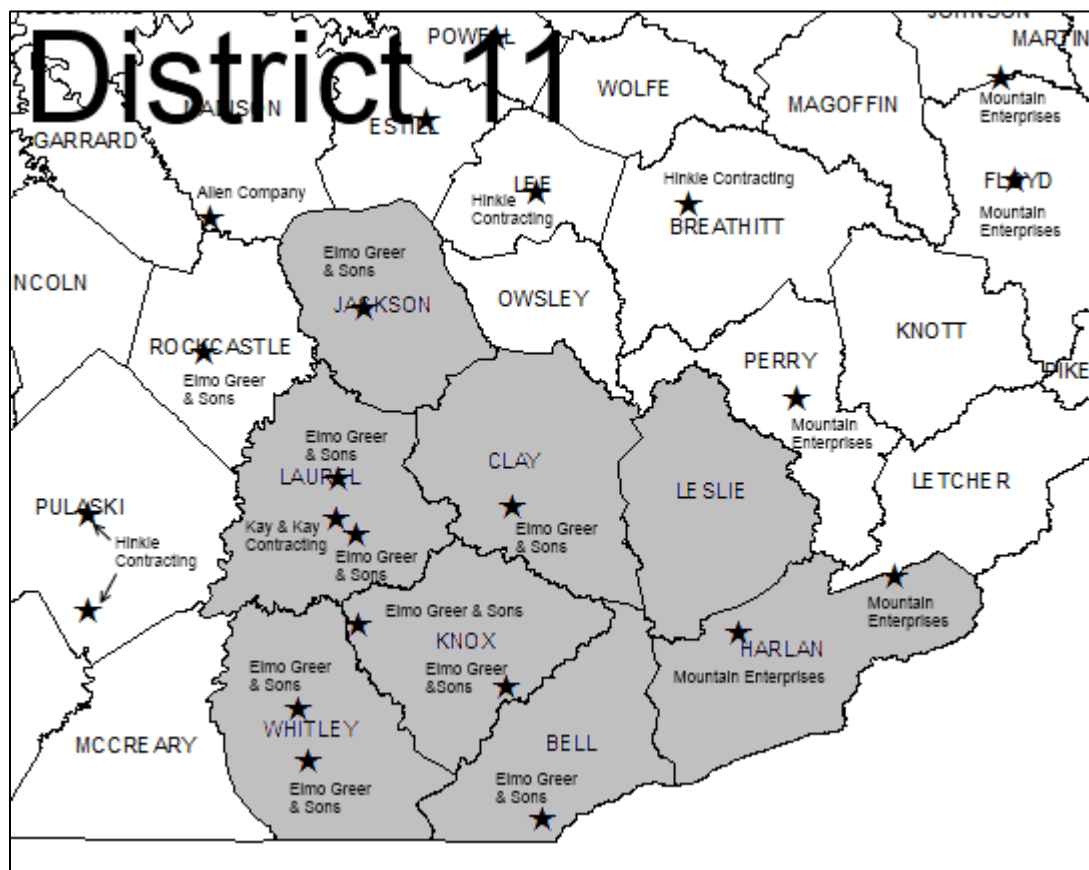


Figure 6.58: Elmo Greer & Sons Service Area

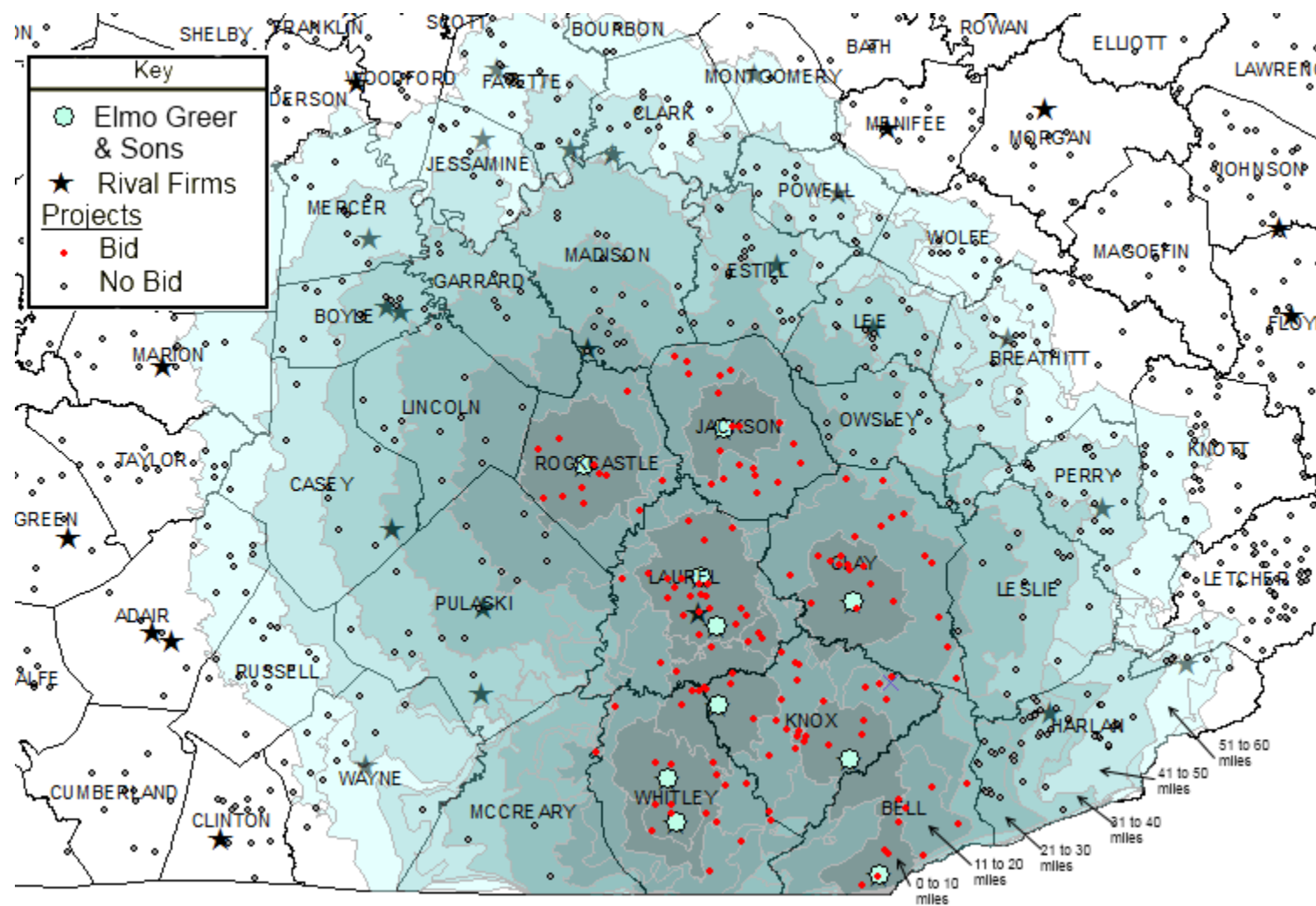


Figure 6.59: Kay & Kay Contracting Service Area

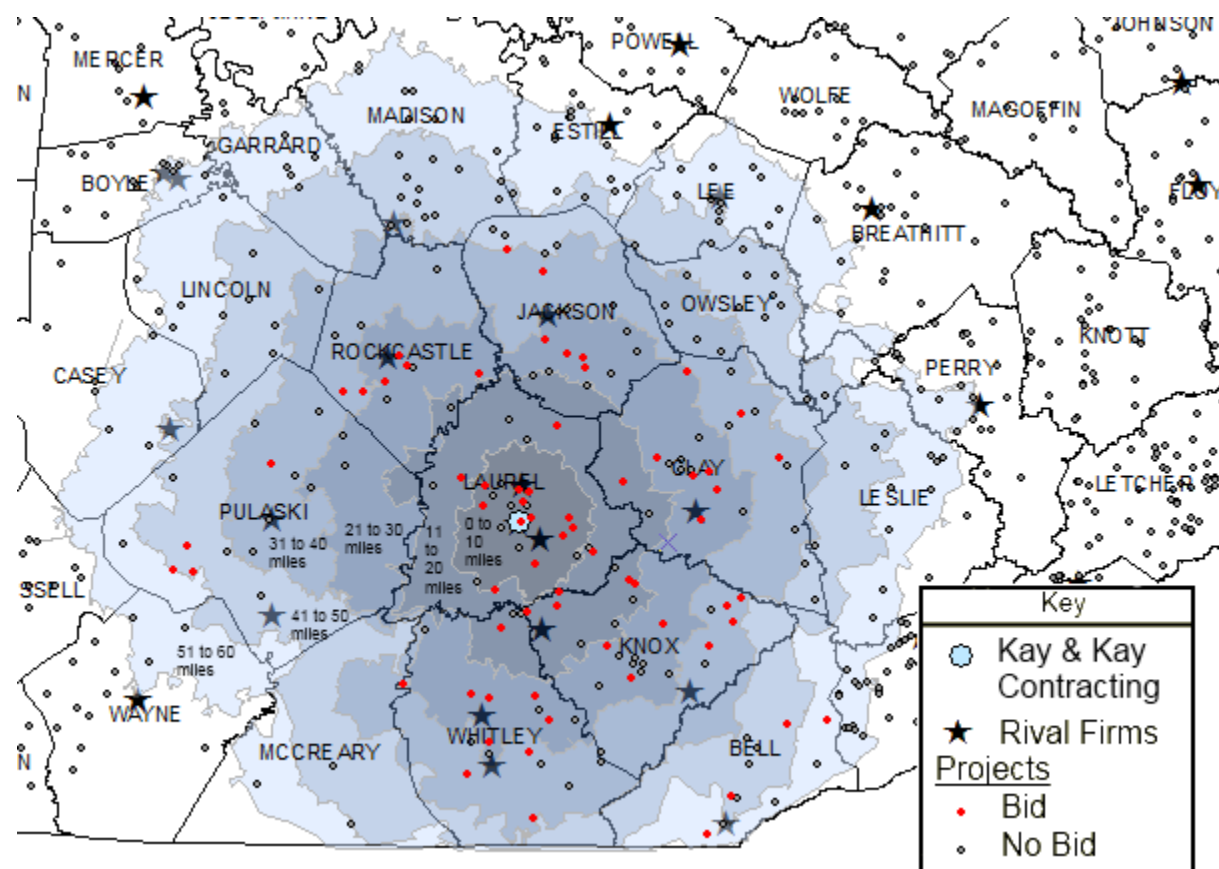
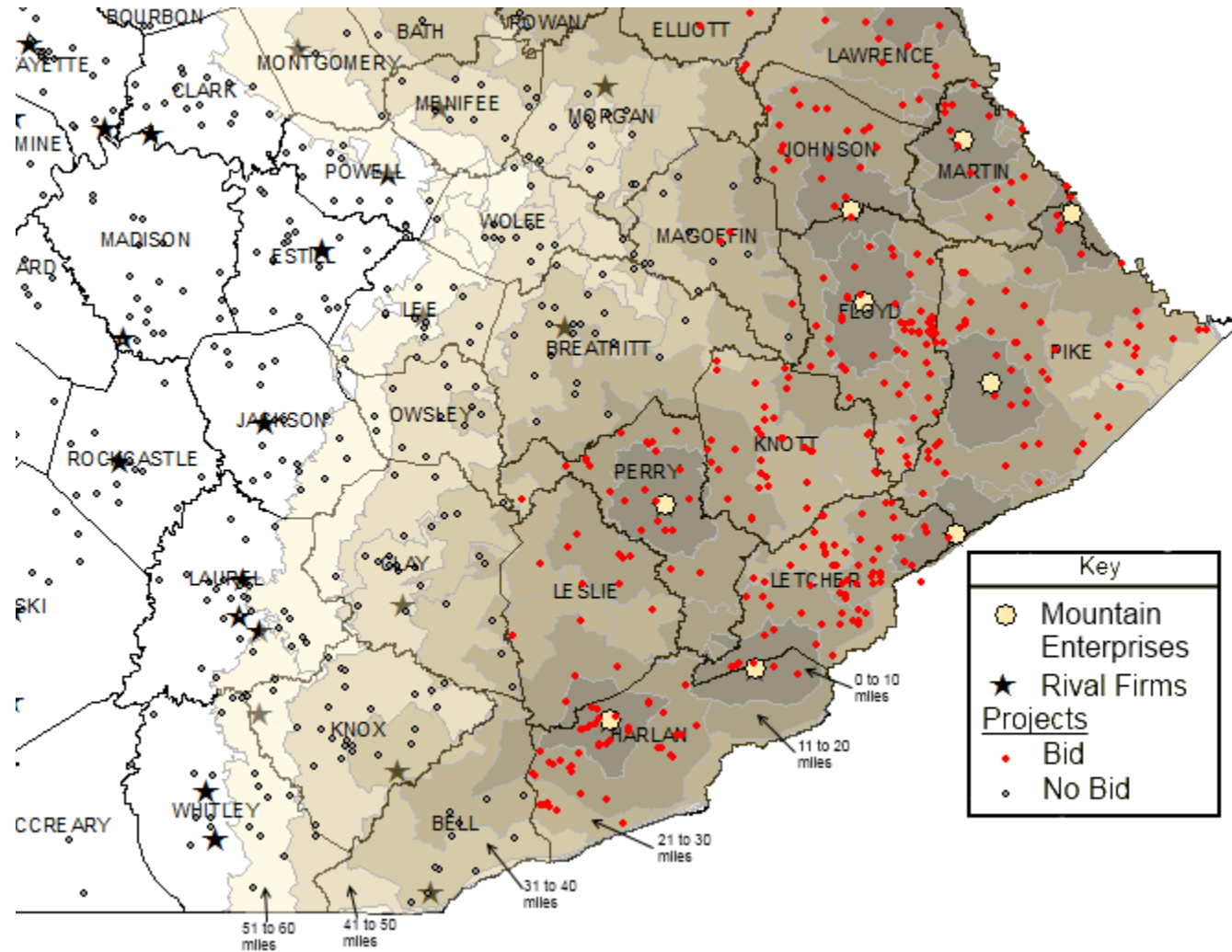


Figure 6.60: Mountain Enterprises Service Area



6.13 District 12 – Eastern Kentucky

District 12 consists of firms in the Eastern Kentucky (see Figure 6.61). Mountain Enterprises is the only firm with plants in the counties in District 12. Blacktop Industries and Hinkle Contracting are the only other firms that could reasonably bid on projects in this district. There is evidence of tacit collusion between Hinkle Contracting and Mountain Enterprises. The result of this tacit collusion is that single-bid contracts are about \$1,329,901.48 above the competitive level for Kentucky. Like District 10, the lack of competition in the District does not allow an accurate indication of how competition impacts bid levels. In this case, the competitive average for Kentucky of 14.28 percent below the engineer's estimate was used.

Floyd, Letcher, and Pike County only have one potential bidder on all projects, Mountain Enterprises. In this case Mountain Enterprises is a monopolist and prices are higher than the competitive level. An analysis of the results for Mountain Enterprises is provided in the following sections along with a more in-depth look at bid data and bid functions. The existence and/or extent of tacit collusion are determined in a county-by-county analysis. To aid this discussion summary statistics and result tables are provided in Table 6.48, Table 6.49, Table 6.50, and Table 6.51. A map for Hinkle Contracting and Mountain Enterprises follows the tables. The additional regression results found in Table 6.51 includes all of the control variables, but only the variation on the county variables is displayed. After the section on each firm, a county-by-county analysis is performed to determine if tacit collusion is occurring.

6.13.1 Firms with Asphalt Plants in District 12

MOUNTAIN ENTERPRISES

FIRM ASPHALT PLANT INFORMATION AND BID VALUES

Mountain Enterprises has seven of their 13 asphalt plants located in District 12. Their primary competitor is Hinkle Contracting in District 10 and Blacktop Industries in District 9. Mountain Enterprises bid on 150 projects in Kentucky, and 74 of those projects are in District 12. They were awarded contracts on all 74 projects. The contracted value of the 74 projects was \$39,558,747.79. The average number of bidders on these projects was 1.08 bidders. There are 68 single-bid projects and the contracted value of these 68 single-bid contracts averaged 5.39 percent above the engineer's estimate.

FIRM BID FUNCTION

The results of the bid function for Mountain Enterprises can be found in Table 6.50. A more in-depth analysis of the bid function is in the District 9 section. I will only go over the highlights in this section. Distance significantly impacts whether or not they bid on a project. The further the project gets from the plant the less likely they will bid on the project. The county variables significantly impacted whether or not they bid on a project. They are less likely to bid on a project in an adjacent county. They are less likely to bid against Hinkle Contracting but do bid on projects in Knott County. More of their bidding behavior will be explored in the “Counties” section.

6.13.2 Counties in District 12

In this section, a more in-depth analysis will occur on a county-by-county basis. Additional regressions were run and variables breaking out specific rival competitors and specific counties without competitors were added (see Table 6.51). The additional regressions for firms outside District 12 will be discussed and included in Table 6.51. In each county there is a group of potential competitors determined by their 60 mile service area. The additional regressions contain the same control variables as the first set of regressions (see Table 6.50). However, these variables were not displayed due to lack of space. Like District 10, the single-bid contracts will be compared to the average of the multi-bid projects for Kentucky which is 14.28 percent below the engineer’s estimate. This is because there is so little competition in District 12 to get a good competitive average. In each county, the number and value of the bids is discussed followed by a discussion on whether or not there is evidence of tacit collusion.

COUNTIES WITHOUT ASPHALT PLANTS

KNOTT COUNTY

There are a total of nine projects in Knott County and only one bidder, Mountain Enterprise, bids on the projects. The total contracted value of these projects is \$3,140,620.10. The project’s contracted value averages 5.39 percent above the engineer’s estimate. Hinkle Contracting is the only other firm that could possibly bid on projects in Knott County. Looking at Figure 6.62, all but one of the projects in Knott County is more than 20 miles and less than 50 miles from the Hinkle Contracting plant in Breathitt County. They are all within the 60 mile service area. The variable of Knott County in the additional regressions shows that Hinkle

Contracting is less likely to bid on projects in Knott County. In turn Mountain Enterprises avoids bidding in counties where Hinkle Contracting has their asphalt plants like Breathitt County (see Table 6.51 and Figure 6.63). There is tacit collusion between these two firms and it results in higher bid levels. This coordination of bid results in bid levels that are \$617,759.97 above the competitive level for Kentucky. The competitive level for bids in Kentucky is 14.28 percent below the engineer's estimate.

COUNTIES WITH ASPHALT PLANTS

FLOYD, JOHNSON, LAWRENCE, LETCHER, MARTIN, AND PIKE COUNTIES

There are a total of 65 projects in the Eastern Kentucky Counties of Floyd, Johnson, Lawrence, Letcher, Martin, and Pike Counties. The total contracted value of these projects is \$36,418,127.69. The projects' contracted value averages 4.82 percent above the engineer's estimate. Hinkle Contracting and Blacktop Industries are the only firms that could reasonably bid on projects in these counties.

Letcher and Pike County cannot be reasonably bid on by Hinkle Contracting or Blacktop Industries (see Figure 6.62 for a map of Hinkle Contracting). Therefore, Mountain Enterprises is the only possible bidder on the 29 projects in these two counties.

In Floyd County, there are 10 projects and Mountain Enterprises is the only bidder. Looking at Figure 6.62, Hinkle Contracting bids on projects in Johnson County and Magoffin County, but in the same distance ring they do not bid on projects in Floyd County. Since not all of the projects in Floyd County fall within their service area they are not considered a potential bidder. While they can bid on some, it is unclear if a project has multiple components and parts of a project are out of the 60 mile service area for Hinkle Contracting. Mountain Enterprises is considered the only firm able to service all projects in Floyd County.

In Johnson County, there are eight projects with four of them having multiple bidders. Blacktop Industries bids on some projects in Johnson County. Looking at Figure 6.62, Hinkle Contracting could bid on projects in Johnson County that are within the same distance rings as in Magoffin County. Mountain Enterprises and Hinkle Contracting do engage in tacit collusion. There is evidence of tacit collusion. This coordination of bidding between Hinkle Contracting and Mountain Enterprises results in bid levels that are \$316,369.61 above the competitive level for

Kentucky.

There are nine projects in Lawrence County with three of them having multiple bidders. Blacktop Industries is the other bidder beside Mountain Enterprises on projects in Lawrence County. Looking at Figure 6.62, Hinkle Contracting could bid on projects in Lawrence County that are within the same distance rings as in Magoffin County and all of the projects in Lawrence County are within their 60 mile service area. These two firms engage in tacit collusion. This coordination of bidding between Hinkle Contracting and Mountain Enterprises results in bid levels that are \$395,771.90 above the competitive level for District 12.

There are nine projects in Martin County with all of them having one bidder. Blacktop Industries could potentially bid on projects in Martin County. The additional regressions in Table 6.51 show there is no collusive arrangement between Blacktop Industries and Mountain Enterprises. Hinkle Contracting cannot reasonably bid on the projects in Martin County. There is no evidence of tacit collusion.

CONCLUSION

In conclusion the pattern of bidding that emerges in District 12 is that no firm except Mountain Enterprises can reasonably bid on all of the projects in Floyd, Letcher, and Pike Counties. For the other three counties, Hinkle Contracting or Blacktop Industries could reasonably bid on some projects in these counties. This competition would put downward pressure on the bids. Where there is evidence of tacit collusion, bids are \$1,329,901.48 above the competitive bid level for Kentucky.

Table 6.48: Summary of Tacit Collusion for District 12 Firms

COUNTY	Multi-bid projects			Single-bid projects			Tacit Collusion		
	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Number of Projects	Contracted Value of Projects	% Value Over/Under Engineer's Estimate	Evidence? (Yes or No)	Firms Involved	Financial Impact
WITHOUT ASPHALT PLANTS									
Knott				9	\$ 3,140,620.10	5.39	Yes	Two Firms (A)	\$ 617,759.97
TOTAL (WITHOUT ASPHALT PLANTS)				9	\$ 3,140,620.10	5.39			
WITH ASPHALT PLANTS									
Floyd				10	\$ 5,875,309.72	4.87	No	One Firm (B)	
Johnson	3	\$ 603,329.20	5.98	5	\$ 1,714,740.42	4.17	Yes	Two Firms (A)	\$ 316,369.61
Lawrence	3	\$ 877,179.10	-7.53	6	\$ 1,842,513.50	7.20	Yes	Two Firms (A)	\$ 395,771.90
Letcher				14	\$ 7,069,779.75	9.47	No	One Firm (B)	
Martin				9	\$ 8,943,287.60	2.68	No	-	
Pike				15	\$ 9,491,988.40	3.24	No	One Firm (B)	
TOTAL (WITH ASPHALT PLANTS)	6	\$ 1,480,508.30	-0.78	59	\$34,937,619.39	5.39			
TOTAL (DISTRICT 12)	6	\$ 1,480,508.30	-0.78	68	\$38,078,239.49	5.39			\$1,329,901.48

(A) These firms include Hinkle Contracting and Mountain Enterprises

(B) This firm is Mountain Enterprises

Table 6.49: Summary Statistics for District 12 Firms

VARIABLES	Mountain Enterprises	
	Mean	Std. Dev.
Dependent: Bid on project? (1=Yes, 0=No)	0.538	0.499
Distance Variables		
Distance (0 to 10 miles) [reference variable]	0.122	0.328
Distance (11 to 20 miles)	0.226	0.419
Distance (21 to 30 miles)	0.183	0.387
Distance (31 to 40 miles)	0.176	0.381
Distance (41 to 50 miles)	0.147	0.355
Distance (51 to 60 miles)	0.147	0.355
Other Control Variables		
Jobs Under Contract	10.12	4.295
Engineer's Estimate	504,063	9.44E+05
Competitive Variables		
Number of Competitor Service Areas	4.179	2.507
Zero other competitive bid proposal purchased [reference variable]	0.452	0.499
One other competitive bid proposal purchased	0.448	0.498
Two other competitive bid proposals purchased	0.0932	0.291
Three or more other competitive bid proposals purchased	0.00717	0.0845
County Variables		
Project in same county-no rival	0.348	0.477
Project in same county-rival	0.0358	0.186
Project in adjacent county-no rival [reference variable]	0.265	0.442
Project in adjacent county-rival	0.351	0.478
Observations	285	

Table 6.50: Regression results for District 12 Firms

VARIABLES	Mountain Enterprises	
	(A)	(B)
Distance (11 to 20 miles)	0.0358 (0.0363)	0.0452 (0.0302)
Distance (21 to 30 miles)	-0.0853* (0.0444)	-0.0297 (0.0377)
Distance (31 to 40 miles)	-0.336*** (0.0674)	-0.221*** (0.0566)
Distance (41 to 50 miles)	-0.482*** (0.0691)	-0.326*** (0.0582)
Distance (51 to 60 miles)	-0.463*** (0.0688)	-0.371*** (0.0606)
Jobs Under Contract	-0.00698** (0.00298)	-0.00363 (0.00244)
Engineer's Estimate	-2.04e-08 (1.51e-08)	-1.35e-08 (8.92e-09)
Potential Competitors	-0.0150*** (0.00528)	-0.0108* (0.00601)
One competitive bid proposal purchased	-0.491*** (0.0632)	-0.320*** (0.0574)
Two competitive bid proposals purchased	-0.548*** (0.0752)	-0.277*** (0.0789)
Three or more competitive bid proposals purchased	-0.761*** (0.137)	-0.439*** (0.113)
Project in same county-rival		0.0151 (0.0481)
Project in adjacent county-no rival		-0.0994*** (0.0333)
Project in adjacent county-rival		-0.418*** (0.0525)
Constant	1.163*** (0.0445)	1.108*** (0.0373)
Observations	279	279
R-squared	0.828	0.878

Robust standard errors in parentheses

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants.

In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Table 6.51: Additional Regression results for Mountain Enterprises and firms outside District 12

VARIABLES	Blacktop Industries			Hinkle Contracting			Mountain Enterprises		
	(B)	(C)	(D)	(B)	(C)	(D)	(B)	(C)	(D)
Project in same county-rival							0.0151 (0.0481)	0.0163 (0.0450)	0.0116 (0.0205)
Project in adjacent county-no rival	-0.704* (0.354)	-0.704* (0.354)		-0.277*** (0.0693)	-0.244*** (0.0650)		-0.0994*** (0.0333)	-0.0742** (0.0344)	
Project in adjacent county-rival	-0.432 (0.265)		-0.434 (0.278)	-0.356*** (0.0769)		-0.683*** (0.111)	-0.418*** (0.0525)		-0.819*** (0.0627)
Project in adjacent county-Blacktop Industries					0.0307** (0.0122)				
Project in adjacent county-Hinkle Contracting								-0.464*** (0.0536)	
Project in adjacent county-Mountain Enterprises		-0.432 (0.265)			-0.331*** (0.0742)				
Project in Knott County						-0.699*** (0.110)			-0.00538 (0.0167)
Constant	1.480** (0.645)	1.480** (0.645)	1.613*** (0.534)	1.057*** (0.0329)	1.059*** (0.0371)	0.994*** (0.0159)	1.108*** (0.0373)	1.144*** (0.0383)	1.049*** (0.0214)
Observations	32	32	32	531	531	531	279	279	279
R-squared	0.309	0.309	0.345	0.892	0.893	0.942	0.878	0.886	0.967

Robust standard errors in parentheses. The control variables were included in the regression but are not displayed

Note: The reference category in all specifications is "Project in same county-no rival".

There are some cases where firms only have plants in counties where other rivals have their plants. In this case "Project in same county-rival" is the reference category.

*** p<0.01, ** p<0.05, * p<0.1

Figure 6.61: District 12

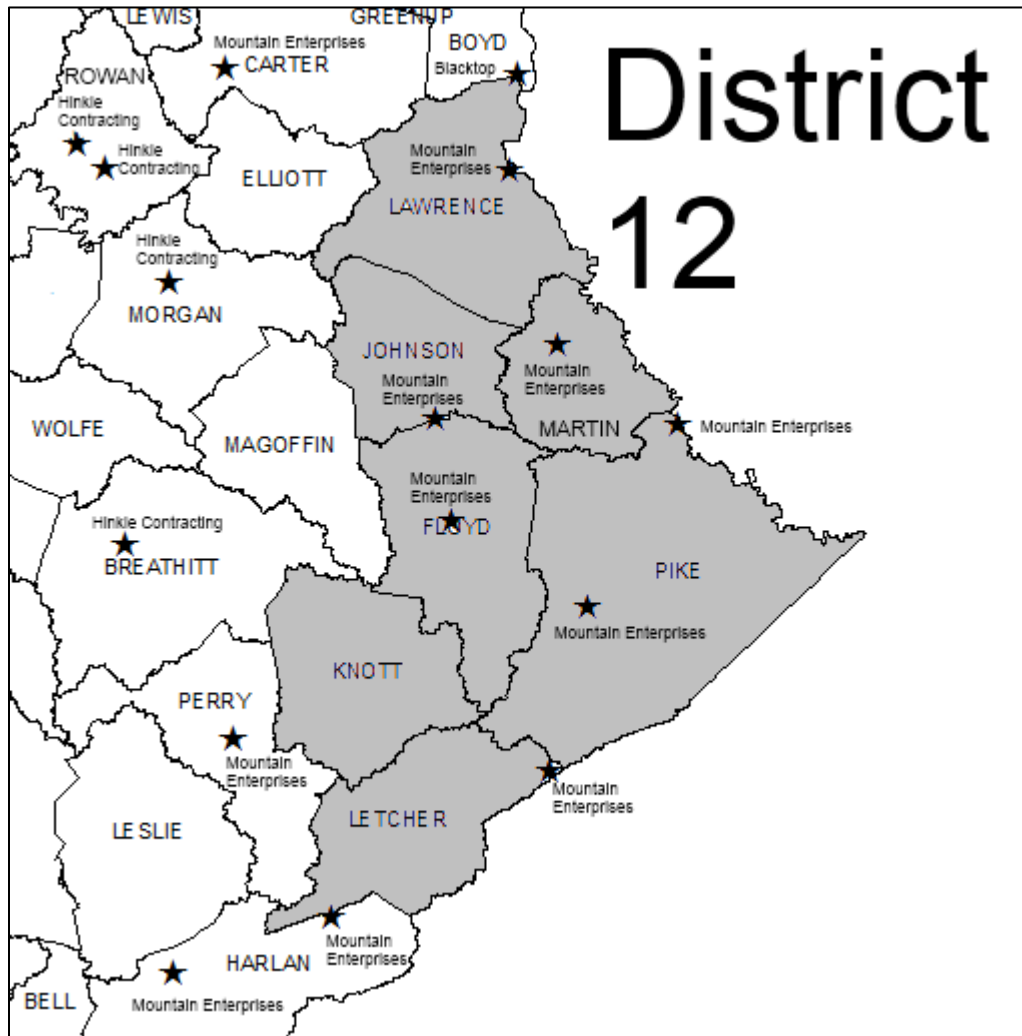


Figure 6.62: Hinkle Contracting Service Area

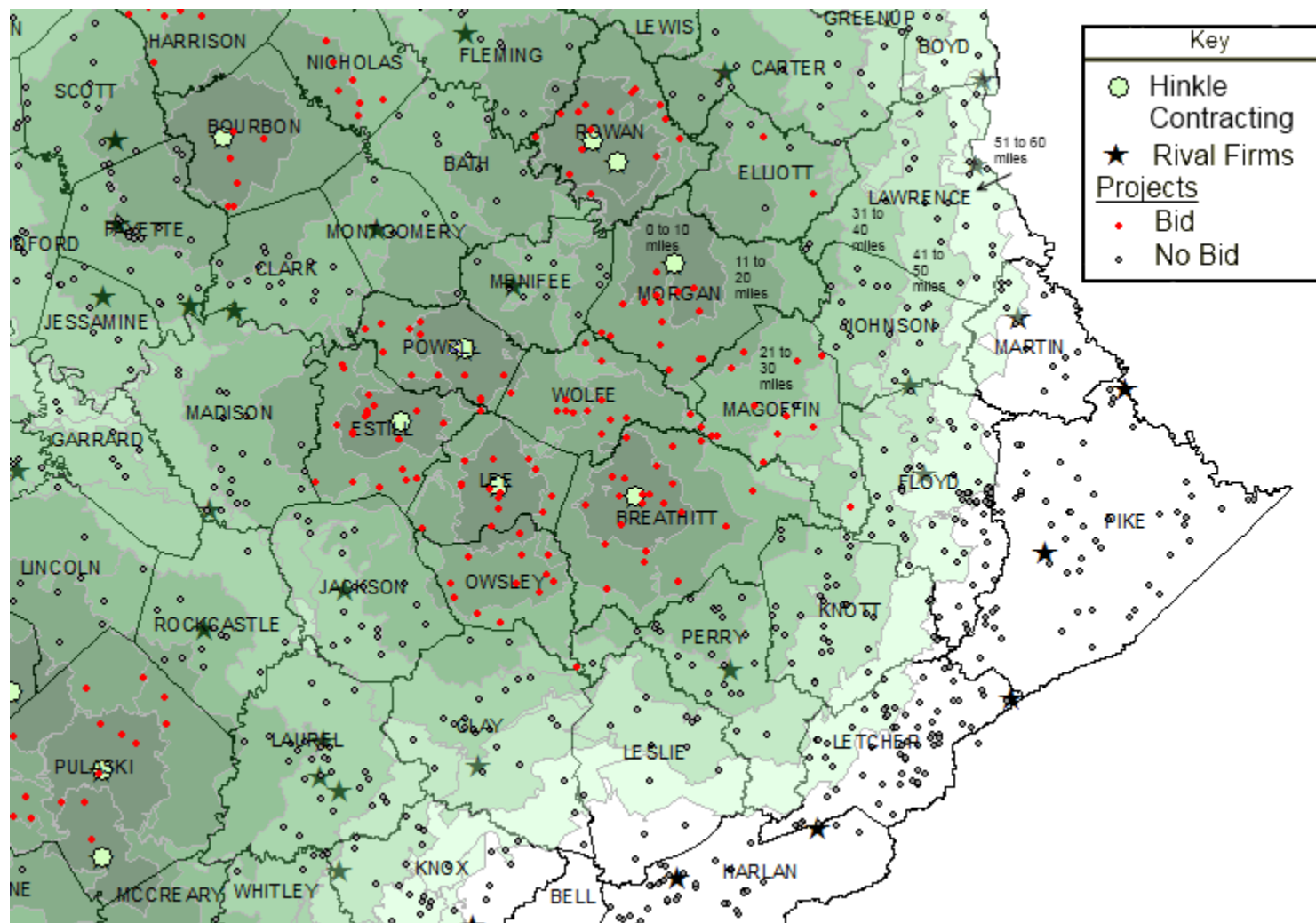
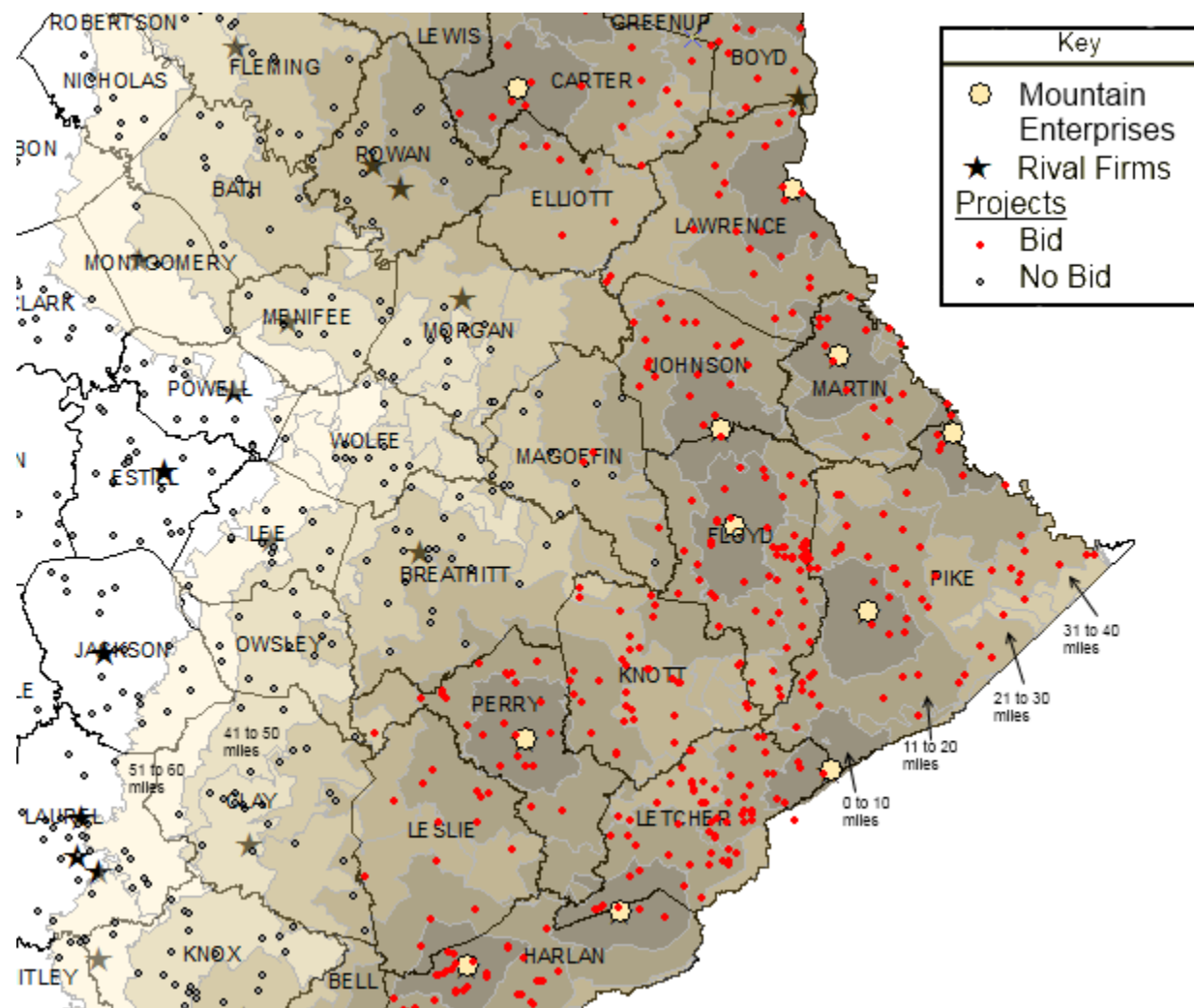


Figure 6.63: Mountain Enterprises Service Area



6.14 Conclusion

The question of interest of this dissertation is whether or not the high level of single-bid contracts is an indication a competitive market working efficiently or a result of tacit collusion. Results of the individual firm analysis and county-by-county analysis just discussed will be summarized in this conclusion.

There is abundant evidence that firms avoid bidding in counties where rival firms have asphalt plants or where a rival firm bids. Twenty-five out of the 31 firms analyzed engage in some sort of tacit collusion. The purpose of coordinating bids is to increase bid levels and behave like a monopolist which results in more revenues to the firm. In 94 out of the 120 counties, I found evidence that firms tacitly colluded and were able to raise bid levels. In 13 out of the 120 counties, I found evidence of tacit collusion but there was no impact on bid levels. Eight counties were competitive, while in five counties only one firm could reasonably bid on the projects. The result in the 94 counties is the tacit collusion leads to a high number of single-bid contracts with only one firm bidding because the other firms refrain from bidding. Single-bid contracts average 2.22 percent above the engineer's estimate, while multi-bid asphalt projects average 14.28 percent below the engineer's estimate. The results indicate that contracted bid levels for single-bid contracts are \$70,595,466.09 higher than the competitive level due to tacit collusion.

Firms in Kentucky carve out territories where they are the exclusive bidder in the county. The other firms refuse to bid in those counties, and the lone bidder is able to increase bid levels above the competitive level for the district. There is evidence that firms maintain this tacit collusion, in some cases, through retaliatory bidding.

There is a continuum of competitive situations found in the counties of Kentucky. There are counties that are competitive with no evidence of tacit collusion such as Meade County. On the other end of the continuum there are counties such as Pike County where Mountain Enterprises is the only viable bidder. In between these two extremes, are counties where evidence of tacit collusion is found, but it has no impact on bid levels. This non-bidding by firms is probably a result of the competitive atmosphere of the county. Jefferson County is an example of where this occurs. There is also a situation where potential competitors refrain from bidding on projects and there is only one bidder on projects in the county and this leads to

higher bid levels. Clark County is an example where this occurs. There is clear evidence of firms using counties boundaries to coordinate bids and engage in a tit-for-tat strategy. In other words, “If you don’t bid in my county, I won’t bid in your county.” Results of each district will be summarized in the next paragraphs.

The pattern of bidding that emerges in District 1 is that H&G Construction and Jim Smith Contracting bid against each other on most projects. Murray Paving sticks to bidding in Calloway County and there is evidence that they collude with Rogers Group. Murray Paving is owned by Jim Smith Contracting and so these two firms are not considered competitors. Rogers Group does not bid in the counties where these firms bid. There is conclusive evidence that Jim Smith Contracting returns the favor and does not bid in Crittenden and Trigg Counties where Rogers Group has their asphalt plants. Road Builders and Scotty’s Contracting also do not bid in these counties. The effect of the tacit collusion is negligible on bids in Lyon and Livingston Counties compared to the competitive level of the district. However, in Crittenden, Graves, McCracken and Trigg Counties bids average above the competitive level. The result is that bids in these counties are \$928,149.29 higher as a result of the lack of competition.

In District 2, Jim Smith Contracting, Mago Construction, Road Builders, Rogers Group, Scotty’s Contracting, and Yager Materials all tacitly collude by not bidding in each other’s territories. There are two counties where there is no conclusive evidence of tacit collusion: Union and Hancock Counties. When added all together, this avoidance of bidding leads to a large number of single-bid contracts that average \$8,921,983.04 above the multi-bid contracts in District 2.

The pattern of bidding that emerges in District 3 is both fascinating and intriguing. There is evidence that Glass Paving and Scotty’s Contracting are engaging in tacitly collusive behavior and it is being maintained through retaliation. When Scotty’s Contracting cheated and bid where they were not “supposed” to bid, Glass Paving retaliated in Edmonson, Metcalfe and Monroe Counties and then the bidding went back to the previous collusive behavior. Nally & Haydon and Gaddie-Shamrock also refuse to bid in Metcalfe County even though they reasonably could. On the other side of the district, Rogers Group does not bid in Todd County and Scotty’s Contracting does not bid in Christian County. These are a few examples of the type of tacit collusion found in District 3. The tacit collusion in District 3 results in bids that are \$5,067,574.59 above the

competitive level. There is no evidence of tacit collusion in Simpson County, because Scotty's Contracting is the only reasonable bidder on all of the projects.

Like District 3, the bidding in District 4 is also interesting. There is evidence that Glass Paving and Scotty's Contracting are coordinating bids and maintaining it through retaliation as discussed in District 3. Firms refrain from bidding in counties where Nally & Haydon Surfacing have their asphalt plants and in Taylor County. Firms also avoid bidding in Nelson County where Mago Construction is the lone bidder on all projects. This tacit collusion results in bids that are \$4,980,890.92 above the competitive level. Not all of the behavior is collusive. In Meade County there are numerous firms that bid on projects and it is very competitive.

District 5 which contains Louisville is very competitive. There is evidence of tacit collusion between firms in every county; however, the counties are still very competitive and bid levels remain at or below the competitive level. In the competitive counties firms probably avoid bidding because there is so much competition, and not as part of a strategy to raise bid levels. There are a few exceptions including Trimble County and Franklin County where there is only one bidder on every project. What is interesting is that in most counties there are anywhere from five to ten firms that are potential competitors. Yet, there is still evidence of tacit collusion with the firm who has the asphalt plant in the county. This tacit collusion results in single-bid contracts that are \$854,582.35 above the competitive level. For a district that had around \$50 million in projects over the sample period, the competition put downward pressure on bids, especially from Indiana firms that kept bid levels well below the engineer's estimate. The effect of the tacit collusion is very low on bid prices.

District 6 in Northern Kentucky is also very competitive. While the bidding is competitive and keeps bid levels low, there is still evidence of tacit collusion in these counties. In Boone, Campbell, Grant and Kenton County the impact of this tacit collusion on bid prices is negligible. Two things could be occurring. Firms could avoid bidding in these four counties because it is so competitive and they know they will lose money if they win the project. Also, firms could be maintaining their collusive agreements across all counties and even in competitive counties. Firms that are engaging in tacit collusion include Barrett Paving and Mago Construction, while there is evidence that Eaton Asphalt Paving and Ohio Valley Asphalt also engage in tacit collusion. There are still counties like Harrison County where firms do not bid and Hinkle

Contracting can increase prices like a monopolist. Where tacit collusion does impact bid levels it results in bids that are \$845,722.12 above the competitive bid level for District 6.

There is a high level of tacit collusion in District 7. There are multiple firms that could bid on projects but do not because they are located in someone else's county. ATS Construction, Lexington Quarry, and The Walker Company all have regressions that suffer from multicollinearity between the county variables and the bid proposal variables. This results in the county variables not giving reliable results. This is due primarily to the firms bidding mainly in their own counties. The maps of these three firms were used in the analysis instead to determine if they were engaging in tacit collusion with the other firms. The general results from District 7 are that firms primarily stick to their own county and do not bid on projects in adjacent county. The result is that in all 12 counties there is evidence of tacit collusion between firms. The financial impact of this is that the tacit collusion results in bids that are \$19,378,600.55 above the competitive level. Around \$12 million of this comes from Fayette County where ATS Construction is the lone bidder and no other competitors bid against them.

Bidding in District 8 is very similar to District 7. Firms avoid bidding in counties where rivals either bid or have asphalt plants. This results in a high number of single-bid projects. There is evidence of tacit collusion in every county. When firms bid where there was typically only one bidder, then bid levels were driven down. However, most firms simply refused to bid on projects in a rival's counties and this increased bid levels. These firms include Elmo Greer & Sons, Gaddie-Shamrock, Hinkle Contracting, and Mago Construction. There are also other firms such as Nally & Haydon Surfacing and The Allen Company that also avoid bidding against these competitors. Where there is firm evidence of tacit collusion bid levels are \$9,060,636.59 above the competitive bid level for District 8.

The pattern of bidding that emerges in District 9 is sporadic. There are counties such as Mason and Lewis Counties where the bidding is very competitive and other counties such as Boyd and Greenup County where Mountain Enterprises dominates the bidding and Blacktop Industries occasionally bids on projects. Firms avoid bidding in Bath County where The Walker Company is the primary bidder, and there is evidence of tacit collusion in this county. Where there is evidence of tacit collusion bids are \$5,996,119.63 above the competitive bid level for District 9. This tacit collusion results in single-bid contracts that are well above the competitive level.

There is little competition in District 10. At times the multi-bid projects have higher percentages above the engineer's estimate than the single-bid contracts. There is not a clear reason why this is occurring. It is possible that overt collusion is occurring or some other form of bid coordination, but there is no evidence to support this claim. There is evidence of tacit collusion in every county in District 10. Like the pattern that occurs in the rest of Kentucky, firms do not bid beyond the counties they regularly bid in. This leads to a high level of single-bid contracts and bid levels that are above the competitive level. Since the competitive bid levels were so odd, the average percentage over/under the engineer's estimate was used from all of Kentucky. The tacit collusion results in bids that are \$4,974,946.94 above the competitive bid level for Kentucky.

In District 11, Kay & Kay Contracting actively bids against Elmo Greer & Sons. This puts downward pressure on the bids. Elmo Greer & Sons tacitly colludes with The Allen Company, Hinkle Contracting, and Mountain Enterprises by not bidding in the counties they have asphalt plants or where they bid. These firms do the same in return. This increases bid levels above the competitive level when Elmo Greer & Sons or Mountain Enterprises is the only bidder. This tacit collusion results in bids that are \$8,226,358.58 above the competitive bid level for District 11.

No firm except Mountain Enterprises can reasonably bid on all of the projects in Floyd, Letcher, and Pike Counties in District 12. I classified Martin County as a monopoly county since Blacktop Industries does not bid and Hinkle Contracting cannot bid in this county. For the other two counties, Hinkle Contracting or Blacktop Industries could reasonably bid on some projects in these counties. However, Hinkle Contracting avoids bidding against Mountain Enterprises. This competition would put downward pressure on the bids. Where there is evidence of tacit collusion, bids are \$1,329,901.48 above the competitive bid level for District 12.

Throughout Kentucky, there is evidence that firms engage in tacit collusion. This tacit collusion is characterized by firms not bidding in counties where their rivals have asphalt plants or where they regularly bid. There are exceptions to this; however, the firms are able to maintain these tacit agreements over the three year period of analysis. Firms do this to raise bid levels above the competitive levels.

7. CHAPTER 7: Conclusions

In this chapter I detail the conclusions from the analysis. I recommend actions that can be taken by the Kentucky Transportation Cabinet to help create more competition in bidding on asphalt paving projects. I then outline the conclusions from each chapter of this dissertation.

In this dissertation I provide an analysis of highway procurement auctions in Kentucky. The question of interest was whether or not firms were coordinating bids with their rivals, which enable them to increase bid levels above the competitive level. The findings indicate that 25 out of 31 firms engage in tacit collusion with their rivals. They are able to coordinate bids using a focal point which enables firms to engage in a tit-for-tat strategy where they refuse to bid in each other's counties. In this case the focal point is the county boundaries. Two factors contribute to the ability for firms to use the county boundaries to coordinate bids. The first factor is that the political county boundaries form relatively small counties which allow a firm's service area to cover multiple counties. The firms are able to claim counties and service the projects in those counties. The second factor is that most asphalt projects which the Kentucky Transportation Cabinet puts up for bidding are excluded to a specific county. According to my calculations, only 2 percent of the asphalt projects are in more than one county. This allows firms to know whether a project falls in a county within their bidding territory. This tacit collusion resulted in the value of the single-bid contracts being \$70,595,466.09 above the competitive level.

There are institutional structures in place that enable firms to engage in tacit collusion. This includes the practice of defining projects based on the county it is located in. There have been efforts in the past to bundle projects across county boundaries. According to Kentucky Transportation officials it has not increased competition. I recommend bundling projects across county boundaries. However, care must be taken to create bundles that are within the service areas of multiple firms. The bundling should be done based on the boundaries of the various firms. This would allow projects to be bundled with other projects in various counties. This could help introduce some competition into the bidding process. The second item that could help increase competition is to not reveal the list of firms that purchased bid proposals until after the bids are revealed. Firms can look at the publically available list and make bidding decisions based on who has purchased bid proposals.

These are the two major recommendations for the Kentucky Transportation Cabinet. While, these efforts could increase competition, the important point is that the county boundaries need to be removed as a method for firms to coordinate bids. The service areas constructed in this dissertation illustrate the fact that firms can be bidding on projects outside of the counties where their plants are located or where they bid regularly. There are cases where only one firm, such as Mountain Enterprises, is the only reasonable bidder. However, 97 percent of projects are within 60 miles of at least two firms. The reason why bid proposals should not be publically available is because firms can use it to help enforce the tacit agreements. Firms can see if a rival is thinking about bidding on a project and they can choose not to bid on the project. The purpose of these recommendations is to encourage more competition in the bidding process. A review of the chapters will help clarify these recommendations.

In Chapter 2, I detailed the history of bid rigging in asphalt paving projects, the planning, design, funding, and bidding of a project, and the asphalt paving process. The important part of this chapter was to understand the institutional detail that leads to and helps firms tacitly collude. These aspects include projects being designated by county, the existence of service areas which limit the scope of the market, and the high-start up costs and economies of scale that limit firms from entering the market. Producing asphalt is a costly endeavor and can lead firms to seek after ways to increase their profit margin by coordinating bids with their rivals.

In Chapter 3, the theoretical literature related to and used for this dissertation was discussed. This literature includes analysis of overt collusion in the asphalt paving industry and how firms coordinated bids. These firms made the bidding look competitive when in fact it was not. Other analysis has been done to try and detect collusion in the seal coating industry. There is also literature about what factors influence whether or not a firm bids on a highway procurement auction. This literature was used to construct a firm's bid function including what factors impact whether or not a firm bids on a project. The purpose of the bid functions was to detect if firms are coordinating bids by using a focal point. The focal point can help firms engage in a tit-for-tat strategy where they refuse to bid in each other territories. This can lead to increases in bid levels and allow the firms engaging in this tit-for-tat strategy to exercise market power.

The theoretical framework in Chapter 4 shows that firms can use the county boundaries to coordinate their bids. This is accomplished by firms not bidding in each other's counties where

the rival firm has an asphalt plant or bids regularly. If the firms cheat they can punish the other firm through retaliatory bidding. If there are no firms located in a county then the outcome is more uncertain. This refusal to bid in each other's counties is a tit-for-tat strategy where firms seek to increase bid levels above the competitive level and increase profits. This strategy can be maintained in a repeated game since the focal point of county boundaries is reinforced by the fact that KYTC lets projects in specific counties.

The data used to answer the question of interest comes from publically available bid data obtained from the Kentucky Transportation Cabinet. The unit of observation is asphalt paving projects from 2005-2007 in Kentucky. All of these projects fall within a firm's 60 mile service area. In order to answer the question of interest, it was important to control for other factors that might influence whether or not a firm bids on a project. These include distance from asphalt plant to project, the number of jobs under contract, the size and scope of the project, and the potential competitors. County variables were created following the theoretical framework in the first half of the chapter. These variables are combined into individual bid functions to see if firms are tacitly colluding.

In Chapter 5, the empirical model was outlined. Since these firms bid against each other month after month, they have to sustain this bidding behavior by using a focal point to coordinate the bids. This allows the firms to engage in a tit-for-tat strategy where one firm refuses to bid in a county where the other firm bids and/or has an asphalt plant, and in turn the other firm reacts by not bidding in the firm's county. To identify this behavior, bid functions were constructed for each firm which included variables which identify if a firm has an asphalt plant in a county. If both firms are tacitly colluding then they are less likely to bid in each other's territories. This same analysis extends to counties without asphalt plants. The overarching purpose of the analysis is to identify which firms are engaging in this tit-for-tat strategy and then identify how much this tacit collusion increases bid levels above the competitive level.

Chapter 6 details the results from all 120 Kentucky counties. There is abundant evidence that firms avoid bidding in counties where rival firms do not have asphalt plants or where a rival firm bids. Twenty-five out of the 31 firms analyzed engage in some sort of tacit collusion. The purpose of coordinating bids is to increase bid levels and behave like a monopolist which results in more profits to the firm. The result is a high number of single-bid contracts with only one firm bidding because the other firms refuse to bid. Single-bid contracts average 2.22 percent above

the engineer's estimate, while multi-bid asphalt projects average 14.28 percent below the engineer's estimate. The results indicate that contracted bid levels for single-bid contracts are \$70,595,466.09 higher than the competitive level due to tacit collusion. Firms in Kentucky carve out territories where they are the exclusive bidder in the county. The other firms refuse to bid in those counties, and the lone bidder is able to increase bid levels above the competitive level for the district. This occurs in 94 out of the 120 counties in Kentucky. There is evidence that firms maintain this tacit collusion, in some cases, through retaliatory bidding.

The recommendations presented in this chapter to bundle the projects based on firms' service areas and not county boundaries could help disrupt firms' claims on certain counties and increase the number of bidders and decrease bid levels in the 94 counties where tacit collusion was detected and where it increased bid levels. The second recommendation to not reveal the firms who purchased bid proposals until after the bids are revealed would help increase competition. The purpose of the recommendations is to make asphalt bidding more competitive in Kentucky.

Appendix

Table 8.1: Asphalt paving bids let by county in all 50 states

	# of Counties	% single-bid contracts (AASHTO Survey)	Contracts by county	Department of Transportation website	Notes
Alabama	67		Yes	www.dot.state.al.us	Most asphalt projects are typically in one county
Alaska	29		No	www.dot.state.ak.us	They group projects into three regions
Arizona	15		Could not be determined	www.azdot.gov	Could not determine from Arizona DOT website
Arkansas	75	11%	Yes	www.arkansashighways.com	Most asphalt projects are typically in one county
California	58		No	www.dot.ca.gov	Does not seem restricted to county
Colorado	64	29%	Yes	www.coloradodot.info	Most asphalt projects are typically in one county
Connecticut	8		No	www.ct.gov/dot	Does not seem restricted to a specific county
Delaware	3		Yes	www.deldot.gov	Most asphalt projects are typically in one county
Florida	67	10%	Yes	www.dot.state.fl.us	Most asphalt projects are typically in one county
Georgia	159		Yes	www.dot.state.ga.us	Most asphalt projects are typically in one county
Hawaii	4		Yes	www.hawaii.gov/dot	Most asphalt projects are typically in one county
Idaho	44		Yes	www.itd.idaho.gov	Most asphalt projects are typically in one county
Illinois	102	30%	Yes	www.dot.il.gov	Most asphalt projects are typically in one county
Indiana	92		Yes	www.in.gov/dot	Most asphalt projects are typically in one county
Iowa	99	19%	Yes	www.iowadot.gov	Most asphalt projects are typically in one county
Kansas	105		Yes	www.ksdot.org	Most asphalt projects are typically in one county
Kentucky	120	70%	Yes	www.transportation.ky.gov	Most asphalt projects are typically in one county
Louisiana	64	34%	Yes	www.dotd.la.gov	Most asphalt projects are typically in one parish
Maine	16	80%	Yes	www.maine.gov/mdot/	Most asphalt projects are typically in one county
Maryland	24		Yes	www.roads.maryland.gov	Most asphalt projects are typically in one county
Massachusetts	14		No	www.massdot.state.ma.us/Highway/	They are not county specific. Could be on city or town level
Michigan	84		Yes	www.michigan.gov/mdot	Most asphalt projects are typically in one county
Minnesota	87		Mixed	www.dot.state.mn.us	I found some asphalt projects that were in multiple counties. A lot of asphalt projects were just in one county.
Mississippi	82	80%	Yes	www.comodot.com	Most asphalt projects are typically in one county
Missouri	115	10%	Mixed	www.modot.org	I found some asphalt projects that were in multiple counties. A lot of asphalt projects were just in one county.
Montana	56	30%	Yes	www.mdt.mt.gov	Most asphalt projects are typically in one county
Nebraska	93	20%	Yes	www.dor.state.ne.us	Most asphalt projects are typically in one county
Nevada	17		Yes	www.nevadadot.com	Most asphalt projects are typically in one county
New Hampshire	10		Mixed	www.nh.gov/dot/	I found most asphalt resurfacing projects were in multiple counties.
New Jersey	21		Yes	www.state.nj.us/transportation	Most asphalt projects are typically in one county
New Mexico	33		Yes	www.nmshtd.state.nm.us	Most asphalt projects are typically in one county
New York	58		Yes	www.nysdot.gov	Most asphalt projects are typically in one county
North Carolina	100	21%	Yes	www.ncdot.gov	Most asphalt projects are typically in one county
North Dakota	53		Yes	www.dot.nd.gov/	Most asphalt projects are typically in one county
Ohio	88		Yes	www.dot.state.oh.us	Most asphalt projects are typically in one county
Oklahoma	77		Yes	www.okladot.state.ok.us	Most asphalt projects are typically in one county
Oregon	36		Yes	www.oregon.gov/ODOT	Most asphalt projects are typically in one county
Pennsylvania	67		Could not find info	www.dot.state.pa.us	Information no readily available on website
Rhode Island	5		Could not be determined	www.dot.state.ri.us	It does not appear that counties are an issue
South Carolina	46	10%	Yes	www.dot.state.sc.us	Most asphalt projects are typically in one county
South Dakota	66		Mixed	www.sddot.com	I found some asphalt projects that were in multiple counties. A lot of asphalt projects were just in one county.
Tennessee	95	30%	Yes	www.tdot.state.tn.us	Most asphalt projects are typically in one county
Texas	254	37%	Yes	www.dot.state.tx.us	Most asphalt projects are typically in one county
Utah	29	33%	Yes	www.udot.utah.gov	Most asphalt projects are typically in one county
Vermont	14	23%	Mixed	www.aot.state.vt.us	I found some asphalt projects that were in multiple counties. A lot of asphalt projects were just in one county.
Virginia	95	30%	Yes	www.virginiadot.org	Most asphalt projects are typically in one county
Washington	39		Mixed	www.wsdot.wa.gov	I found some asphalt projects that were in multiple counties. A lot of asphalt projects were just in one county.
West Virginia	55	33%	Yes	www.transportation.wv.gov	Most asphalt projects are typically in one county
Wisconsin	72		Yes	www.dot.state.wi.us	Most asphalt projects are typically in one county
Wyoming	23		Could not find info	www.dot.state.wy.us	Information no readily available on website

Table 8.2: Probit results for 11 firms in Kentucky – without county variables

	<i>ATS</i>	<i>The Allen Company</i>	<i>Commercial Pavers</i>	<i>Flynn Brothers</i>	<i>HG Mays</i>	<i>Mago Construction</i>	<i>The Walker Company</i>	<i>Hinkle Contracting</i>	<i>Mountain Enterprises</i>	<i>Elmo Greer & Sons</i>	<i>Kay & Kay Contracting</i>
Number of observations	84	150	94	101	122	332	110	336	204	169	121
X ²	30.73	43.04	22.74	31.46	33.52	92.21	23.77	84.3	40.47	43.03	46.64
Degrees of freedom	4	4	4	4	4	4	4	4	4	4	4
Pseudo R ²	0.5509	0.2269	0.3721	0.3467	0.3761	0.3913	0.5997	0.4394	0.4554	0.7992	0.5264
Log likelihood	-21.692709	-76.622434	-40.252684	-40.683752	-47.698676	-125.15116	-22.579429	-119.50692	-63.065214	-23.210401	-35.280282
<i>Variables</i>											
Log of Distance	-1.5948 *** (0.313)	-0.9821 *** (0.173)	-0.5836 *** (0.162)	-0.5741 *** (0.169)	-1.8270 *** (0.319)	-1.9964 *** (0.210)	-3.5958 *** (0.783)	-1.9388 *** (0.222)	-2.2940 *** (0.377)	-3.7162 *** (0.606)	-0.9562 *** (0.204)
Jobs Under Contract	-0.1641 (0.133)	-0.0516 (0.063)	0.0172 (0.105)	0.3842 (0.237)	-0.0778 (0.092)	0.0008 (0.044)	0.0726 (0.078)	-0.0186 (0.034)	-0.0841 *** (0.031)	-0.0163 (0.066)	0.1147 (0.087)
Log of Engineer's Estimate	0.2645 * (0.160)	-0.3265 *** (0.120)	-0.2570 * (0.159)	-0.7818 *** (0.213)	0.0027 (0.151)	-0.0526 (0.113)	0.1000 (0.211)	-0.2231 ** (0.094)	0.0057 (0.140)	-0.0874 (0.216)	-0.3401 * (0.175)
Log of Number of bid proposals	0.5714 (0.583)	0.9991 *** (0.299)	2.1905 *** (0.738)	1.8742 *** (0.441)	0.6864 ** (0.313)	-0.0992 (0.163)	1.2865 * (0.770)	-0.1435 (0.318)	-0.7313 (0.476)	1.0535 * (0.598)	2.6252 *** (0.490)
Constant	-0.7245 (2.097)	6.2436 *** (1.753)	2.2937 (2.105)	8.5928 *** (2.625)	4.3614 ** (2.174)	5.4767 *** (1.544)	7.6902 *** (2.920)	8.0549 *** (1.403)	8.1287 *** (2.220)	10.8595 *** (3.356)	5.2473 ** (2.378)

Note: Significance: * (10%), ** (5%), *** (1%); Robust standard errors are in parentheses.

Table 8.3: Probit results for 11 firms in Kentucky – with county variables

	<i>ATS</i>	<i>The Allen Company</i>	<i>Commercial Pavers</i>	<i>Flynn Brothers</i>	<i>HG Mays</i>	<i>Mago Construction</i>	<i>The Walker Company</i>	<i>Hinkle Contracting</i>	<i>Mountain Enterprises</i>	<i>Elmo Greer & Sons</i>	<i>Kay & Kay Contracting</i>
Number of observations	46	61	94	101	98	326	97	262	164	56	121
X ²	44.11	10.25	26.89	34.1	21.2	118.48	23.04	58.72	20.65	-	-
Degrees of freedom	5	5	7	7	5	6	5	5	6	1	6
Pseudo R ²	0.5707	0.1059	0.4451	0.4002	0.2749	0.5939	0.3726	0.3549	0.3661	1	0.6333
Log likelihood	-13.670515	-31.385997	-35.572664	-37.356382	-30.413652	-80.585792	-20.195474	-68.820542	-27.210982	-2.298E-09	-27.317196
<i>Variables</i>											
Log of Distance	-0.3856 (0.431)	0.0242 (0.258)	0.2594 (0.383)	-0.5057 (0.371)	-0.3546 (0.434)	-1.5034 *** (0.270)	-2.7961 *** (0.901)	-0.5145 (0.347)	-1.4758 *** (0.570)	-28.5669 -	-1.6358 *** (0.364)
Jobs Under Contract	-0.3345 ** (0.155)	-0.1445 (0.109)	-0.0192 (0.108)	0.4772 * (0.258)	0.0075 (0.129)	0.0216 (0.049)	0.0773 (0.087)	-0.0190 (0.045)	-0.1200 ** (0.053)	2.5106 -	0.1619 (0.107)
Log of Engineer's Estimate	0.0394 (0.162)	-0.1421 (0.188)	-0.2388 (0.150)	-0.7629 *** (0.221)	0.1561 (0.154)	0.0322 (0.125)	0.1195 (0.220)	-0.1997 (0.133)	-0.0714 (0.178)	-0.5334 *** (0.107)	-0.3858 ** (0.187)
Log of Number of bid proposals	1.0321 *** (0.391)	-0.9232 ** (0.463)	2.0619 * (1.242)	2.9523 *** (0.892)	1.1301 *** (0.410)	0.4931 ** (0.245)	1.9340 *** (0.642)	-0.4464 (0.456)	-1.2636 ** (0.593)	26.9769 -	3.2301 *** (0.577)
Project in same county-no rival	2.4934 *** (0.850)	-1.0616 *** (0.395)			‡(20)	1.1651 *** (0.362)	‡(13)	‡(74)	0.4559 (0.342)	‡(60)	
Project in same county-rival		‡(11)	1.7551 *** (0.661)	0.6734 (0.779)	‡(4)	‡(6)			-0.2051 (0.661)	‡(12)	6.2485 ** (2.598)
Project in adjacent county-rival	‡(38)	‡(78)	reference	reference	-1.5170 *** (0.407)	-1.5848 *** (0.260)	-0.8078 ** (0.406)	-2.0112 *** (0.384)	‡(43)	‡(41)	8.4220 *** (2.622)
Project in adjacent county-no rival	reference	reference			reference	reference	reference	reference	reference	reference	reference
Commercial Pavers bid proposal				-0.6143 (0.544)							
Flynn Brothers bid proposal			0.2036 (0.486)								
Gohmann bid proposal			-0.6713 (1.041)	-1.4996 ** (0.644)							
Constant	-0.6343 (2.321)	3.8685 (2.565)	0.1142 (2.159)	8.1493 ** (3.216)	-2.3803 (2.463)	2.8748 (1.757)	5.2283 (3.414)	4.0287 * (2.159)	7.8652 *** (2.451)	31.0337 *** (1.774)	-0.5507 -

Note: Significance: * (10%), ** (5%), *** (1%); Robust standard errors are in parentheses.

‡: Variable dropped because "predicts failure perfectly." Number in parenthesis is the number of observations dropped.

‡: Variable dropped because "predicts success perfectly." Number in parenthesis is the number of observations dropped.

Figure 8.1: Diagram of Asphalt Paving

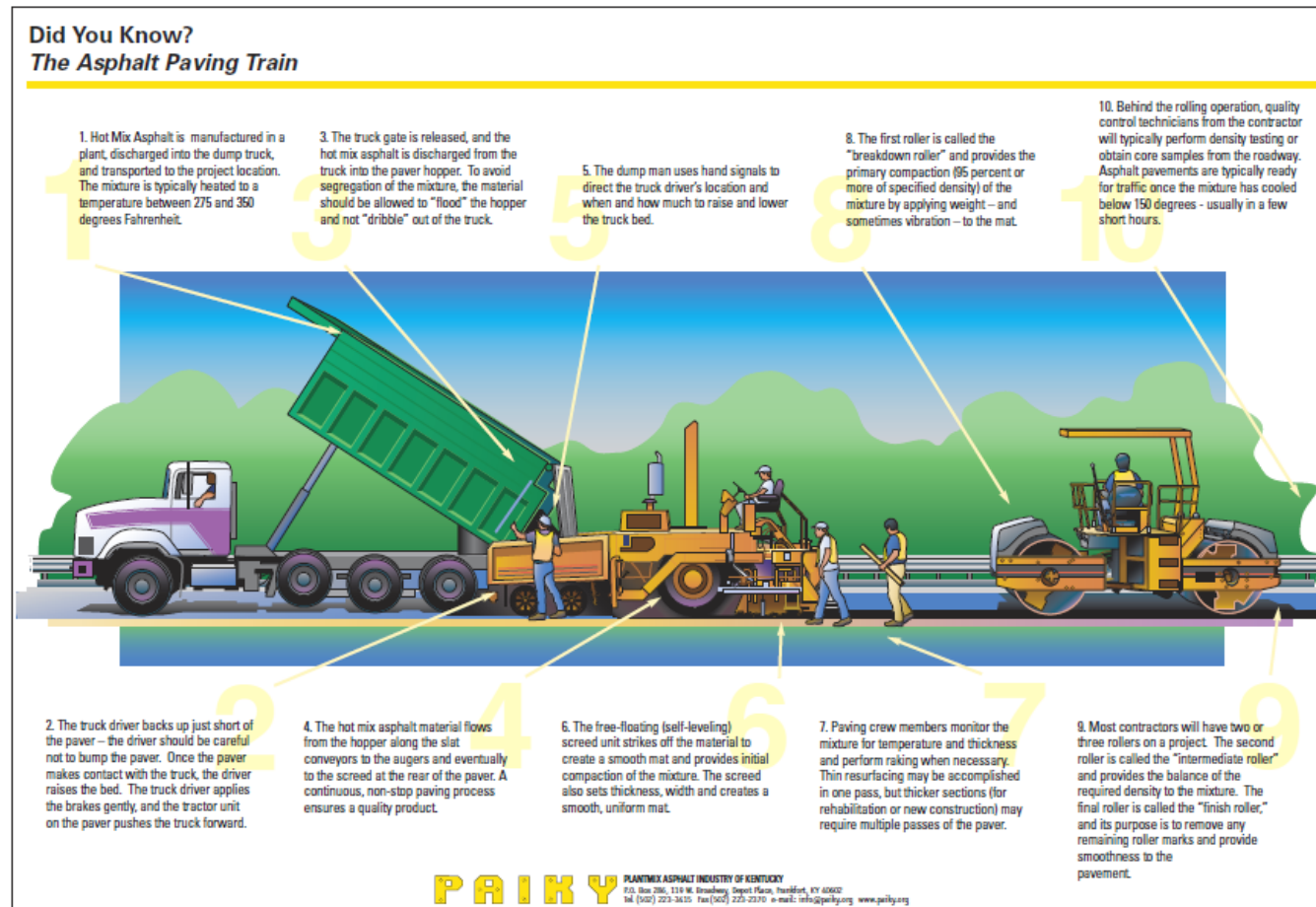
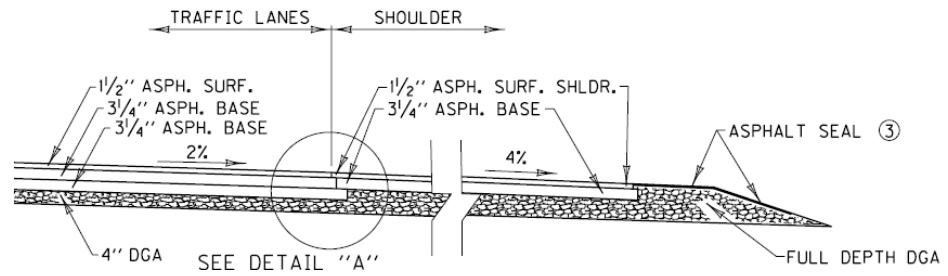


Figure 8.2: Layers of Asphalt Road in Kentucky



Source: (Kentucky Transportation Cabinet, 2006a)

Figure 8.3: Asphalt project delivery process

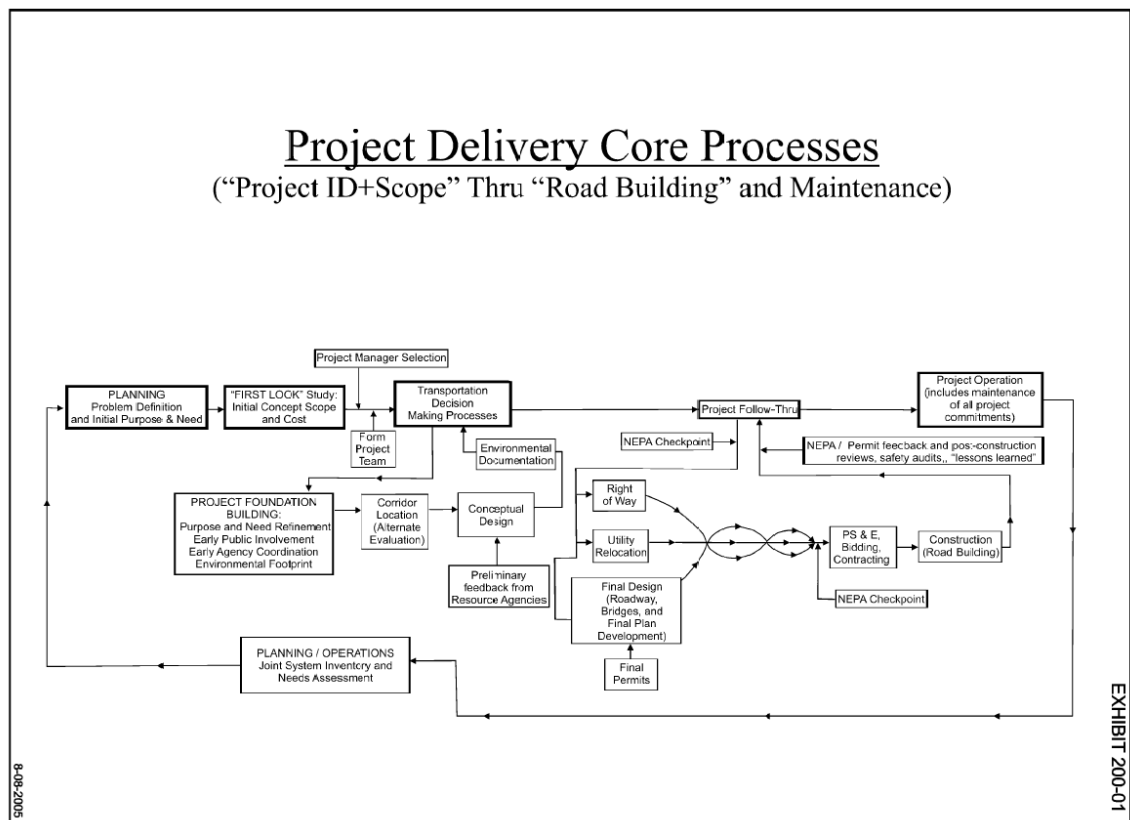


Figure 8.4: Approved Kentucky Quarries Source List – Crushed Stone

AGGREGATE SOURCE LIST

- (1) Approved to supply bituminous fine aggregate only.
- (2) Approved for fine aggregate only.
- (3) Not approved for concrete coarse aggregate.

CRUSHED STONE SOURCES

<u>Source</u>	<u>Producer</u>	<u>District</u>
AGP000201	MARTIN MARIETTA @ SMITHLAND	01
AGP000301	VULCAN MATERIALS COMPANY @ GRAND RIVERS	01
AGP000501	ROGERS GROUP INC. @ CANTON	01
AGP000601	ROGERS GROUP INC. @ MARION	01
AGP000701	HOPKINSVILLE AGGREGATES @ HOPKINSVILLE	02
AGP001101	ROGERS GROUP INC. @ PRINCETON (3)	02
AGP001201	MARTIN MARIETTA @ FREDONIA	02
AGP001401	CEMEX @ HARTFORD	02
AGP001501	GREENVILLE QUARRIES @ GREENVILLE	02
AGP001601	CEMEX SOUTH @ BOWLING GREEN	03
AGP001801	CEMEX NORTH @ BOWLING GREEN	03
AGP002101	SCOTTY'S CONTRACTING @ SCOTTSVILLE	03
AGP002201	HANSON AGGREGATES @ WOODBURN	03
AGP002301	HANSON AGGREGATES @ RUSSELLVILLE	03
AGP002901	SCOTTY'S CONTRACTING @ TOMKINSVILLE	03
AGP003101	HANSON AGGREGATES @ UPTON	04
AGP003301	VULCAN MATERIALS COMPANY @ FORT KNOX (3)	04
AGP003501	VULCAN MATERIALS COMPANY @ BRANDENBURG	04
AGP003601	RIVERSIDE STONE @ WOLFE CREEK	04
AGP003701	LITER'S, INC. @ IRVINGTON	04
AGP003801	WHITE STONE CO. (MAGO) @ HARDINSBURG (3)	04
AGP003901	SCOTTY'S CONTRACTING @ LEITCHFIELD	04
AGP004101	CEDAR CREEK QUARRY #2 @ BARDSTOWN (AGG)	04
AGP004301	NALLY & HAYDON @ LEBANON (AGG)	04
AGP004401	NALLY & HAYDON @ GREENSBURG	04
AGP004601	HART COUNTY STONE @ HORSE CAVE	04
AGP004701	MULZER CRUSHED STONE @ CAPE SANDY, INDIANA	04
AGP004901	HANSON AGGREGATES- ATKINS @ JEFFERSONVILLE, IN	05
AGP005101	HARROD STONE @ FRANKFORT	05
AGP005701	QUALITY CRUSHED STONE @ SHEPHERDSVILLE	05
AGP005801	BULLITT COUNTY STONE @ SHEPHERDSVILLE	05
AGP005901	JEFFERSON COUNTY STONE @ LOUISVILLE	05
AGP006201	LITER'S, INC. @ LOCKPORT (AGG)	05
AGP006301	CARMEUSE LIME & STONE, INC. @ BUTLER	06
AGP006401	HILLTOP STONE @ BUTLER	06
AGP006601	HANSON AGGREGATES @ LAWRENCEBURG	07
AGP006701	BOURBON LIMESTONE @ PARIS	07
AGP006801	CALDWELL STONE @ DANVILLE	07
AGP006901	VULCAN MATERIALS COMPAN@ LEXINGTON-FRANKFORT PIKE	07
AGP007001	VULCAN MATERIALS COMPANY @ LEXINGTON-RICHMOND RD	07
AGP007301	LEXINGTON QUARRY COMPANY @ NICHOLASVILLE	07
AGP007401	BOONESBORO QUARRY @ BOONESBORO	07
AGP007501	MERCER COUNTY STONE @ HARRODSBURG	07
AGP007601	POWELL STONE @ JEFFERSONVILLE	07
AGP007701	NALLY & GIBSON @ GEORGETOWN	07
AGP008101	HANSON AGGREGATES @ MT VERNON	08
AGP008201	CASEY STONE CO @ LIBERTY	08
AGP008601	GADDIE SHAMROCK @ ALBANY (AGG)	08

Figure 8.4 (continued)

AGP008701	BASSETT PRODUCTS @ MONTICELLO	08
AGP008801	LAKE CUMBERLAND STONE @ BURNSIDE	08
AGP008901	SOMERSET STONE @ SOMERSET	08
AGP009201	HANSON AGGREGATES @ PEEBLES, OHIO	09
AGP009401	MOUNTAIN MATERIALS @ CARTER CITY	09
AGP010001	HANSON AGGREGATES @ FLEMINGSBURG	09
AGP010201	TIPTON RIDGE STONE @ RAVENNA	10
AGP010801	NATURAL BRIDGE STONE @ STANTON	10
AGP011001	MENIFEE STONE @ FRENCHBURG	10
AGP011201	CEMEX @ BLEDSOE	11
AGP011301	JELICO STONE CO @ JELICO, TENNESSEE	11
AGP011401	EWING STONE @ EWING, VIRGINIA	11
AGP011701	THE ALLEN CO @ CLOVER BOTTOM	11
AGP011901	MOUNTAIN AGGREGATES @ BURDINE, KY	12
AGP012001	CEMEX @ CUMBERLAND	12
AGP012301	MOUNTAIN AGGREGATES @ ELKHORN CITY, KY	12
AGP012701	OLDHAM COUNTY STONE @ CRESTWOOD	05
AGP013001	MONTGOMERY STONE @ MT STERLING	07
AGP014101	BUTLER COUNTY MATERIALS @ MORGANTOWN (AGG)	03
AGP014401	CAVE RUN STONE @ MOREHEAD	10
AGP015401	SCOTT COUNTY STONE @ SCOTTSBURG, IN	05
AGP015901	HANSON AGGREGATES-COOP LANE @ SELLERSBURG, IN	05
AGP016201	CARMEUSE LIME & STONE, INC. @ MAYSVILLE (3) (AGG)	09
AGP016501	GADDIE SHAMROCK @ COLUMBIA (AGG)	08
AGP016701	E. DILLON AND COMPANY @ SWORDS CREEK, VIRGINIA (3)	12
AGP016901	CORYDON STONE & ASPHALT @ CORYDON, INDIANA (AGG)	05
AGP017001	SELLERSBURG STONE @ SELLERSBURG, INDIANA (AGG)	05
AGP018801	VULCAN MATERIALS COMPANY @ FRANKLIN, TN	03
AGP018901	VULCAN MATERIALS COMPANY @ PARSONS, TN	01
AGP019201	MULZER CRUSHED STONE @ CHARLESTOWN, INDIANA	05
AGP019401	HANSON AGGREGATES @ SOMERSET LAUREL	08
AGP020401	VULCAN MATERIALS COMPANY @ BIG STONE GAP, VIRGINIA	12
AGP020601	VULCAN MATERIALS COMPANY @ TAZEWEILL, TENNESSEE	11
AGP020901	LAFARGE @ CAVE-IN-ROCK, ILL	01
AGP021101	DIX RIVER STONE @ LANCASTER	07
AGP021301	CEMEX @ PINEVILLE	11
AGP021601	SCOTTY'S CONTRACTING @ GLASGOW	03
AGP021801	GRASSY STONE @ CARTER CITY	09
AGP021901	VULCAN MATERIALS COMPANY @ CECILIA	04
AGP022001	VULCAN MATERIALS COMPANY @ HERMITAGE, TN	03
AGP022401	HANSON AGGREGATES-AGGROCK @ SELLERSBURG, INDIANA	05
AGP022601	VULCAN MATERIALS COMPANY @ HARRISON CO., IN	04
AGP022701	MELVIN STONE @ SABINA, OHIO	06
AGP022901	HANSON AGGREGATES (EAGLE) @ FINCASTLE, OHIO	09
AGP023001	HANSON AGGREGATES AA STONE @ GRAYSON	09
AGP023101	SCOTTY'S CONTRACTING @ LOVE KNOB	03
AGP023201	WOODWAY STONE @ PENINGTON GAP, VIRGINIA	11
AGP023601	STERLING MATERIALS @ VERONA	06
AGP024001	HANSON AGGREGATES @ VERSAILLES, INDIANA	06
AGP024101	MULZER CRUSHED STONE @ MAUCKPORT, INDIANA	04
AGP024501	HILLTOP BIG BEND QUARRY @ BATTLETOWN	04
AGP024701	HANSON AGGREGATES @ NORTH VERNON, INDIANA (1)	05
AGP025001	HANSON AGGREGATES @ CLOVERDALE (1)	05
AGP025301	WINN MATERIALS @ CLARKSVILLE, TN	02
AGP025401	BURTON STONE @ COLUMBIA	08

Figure 8.4 (continued)

AGP025601	APEX QUARRY @ WHITE PLAINS	02
AGP025701	VULCAN MATERIALS COMPANY NO. 2 @ GOLCONDA, ILLINOIS	01
AGP026201	TITAN AMERICA RESOURCE @ SALEM	01
AGP026301	VULCAN MATERIALS COMPANY @ LAKE CITY	01
AGP026601	ROGERS GROUP @ GORDONSVILLE, TN	03
AGP026701	LATHAM STONE INC. @ LATHAM, OHIO	09
AGP026801	ROGERS GROUP, INC. @ CARYVILLE, TENNESSEE	11
AGP026901	ROGERS GROUP, INC. @ JACKSBORO, TENNESSEE	11
AGP027001	KAY AND KAY QUARRY @ SOMERSET	08
AGP027201	TNT STONE, INC. @ WILLIAMSBURG (3)	11
AGP027401	WARREN PAVING (SLATS LUCUS QUARRY) @ SALEM (3) (AGG)	01
AGP027701	ARCH MATERIALS @ BATAVIA, OHIO (3)	06

Source: (Kentucky Transportation Cabinet, 2010b)

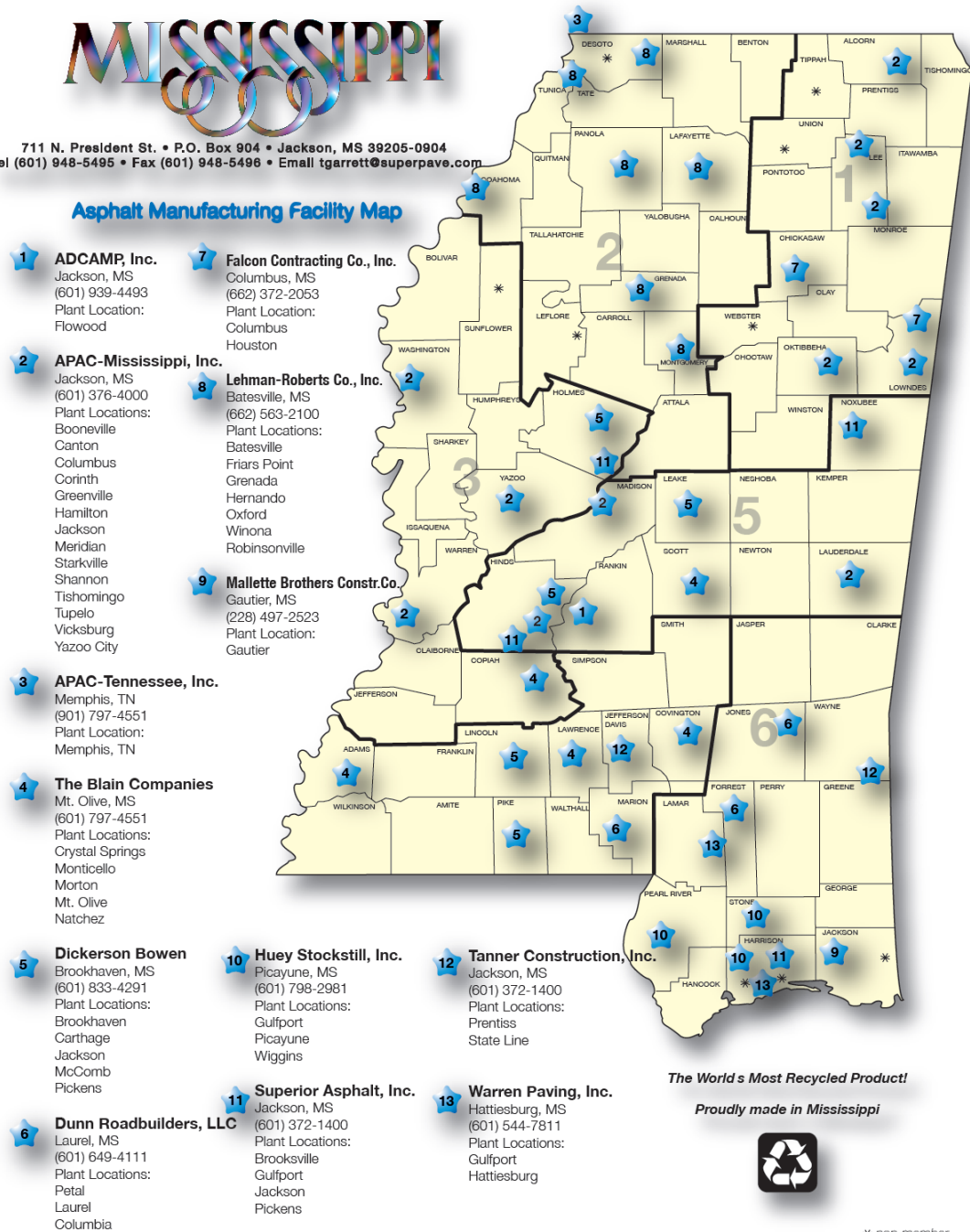
Figure 8.5: Approved Kentucky Quarries Source List – Sand and Gravel

SAND AND GRAVEL SOURCES

<u>Sources</u>	<u>Producer</u>	<u>District</u>
AGP000202	INGRAM MATERIALS @ LEDBETTER (2)	01
AGP000402	IMI-SOUTH (DELTA DIVISION) @ STURGIS (2)	02
AGP000602	HENDERSON MATERIALS @ HENDERSON (2)	02
AGP000702	YAGER MATERIALS @ OWENSBORO (2)	02
AGP000902	CLOVERPORT SAND AND GRAVEL @ HARDINSBURG (1)	04
AGP001002	MAUCKPORT SAND AND GRAVEL @ MAUCKPORT, INDIANA (2)	04
AGP001502	NUGENT SAND @ LOUISVILLE-RIVER ROAD	05
AGP002302	NUGENT SAND @ MILTON	06
AGP003202	HILLTOP BASIC RESOURCES @ PATRIOT, INDIANA	06
AGP004202	SHELLY MTRLS INC. RACINE@ LETART FALLS, OH (2)	09
AGP005202	GLASS SAND AND GRAVEL @ JONESVILLE (AGG) (2)	04
AGP005802	MID SOUTH CONSTUCTION CO. @ HICKORY (2)	01
AGP006002	IMI-SOUTH (DELTA DIVISION) @ HENDERSON (2)	02
AGP006302	HANSON AGGREGATES @ PIKETON, OHIO (2)	09
AGP006502	MARTIN MARIETTA @ HARRISON, OHIO	06
AGP006702	M AND M CONSTRUCTION @ NEW ALBANY, INDIANA (1)	05
AGP007202	LAKE CITY MINING COMPANY (1) @ GILBERTSVILLE, KY	01
AGP009502	MARTIN MARIETTA @ FAIRFIELD, OHIO	06
AGP009702	NORTHERN KENTUCKY AGGREGATES @ PETERSBURG	06
AGP010302	MARTIN MARIETTA @ ROSS, OHIO	06
AGP011102	WELCH SAND & GRAVEL S. @ ROSS, OHIO (2)	06
AGP012102	WATSON GRAVEL @ ROSS, OHIO	06
AGP013202	WELCH SAND & GRAVEL @ HARRISON, OHIO (2)	06
AGP013802	MARTIN MARIETTA @ HAMILTON, OHIO	06
AGP014002	BELLEVUE SAND & GRAVEL, INC. @ BELLEVUE (AGG)	06
AGP014802	SOUTH CENTRAL SAND & GRAVEL @ PIKETON, OHIO (2)	09
AGP015302	SAND SOURCE, LLC @ PINEVILLE (2)	11
AGP015502	BCE MATERIALS @ WHEELERSBURG, OHIO (2)	09
AGP015702	WELCH SAND & GRAVEL @ ALMO (1)	01
AGP015902	LITER'S, INC. @ TRIMBLE COUNTY (2) (AGG)	05
AGP016102	IMI @ LEDBETTER (2)	01
AGP016302	WEST KENTUCKY ASPHALT & MATERIALS @ MURRAY (2)	01
AGP016602	I-164 SAND PIT @ EVANSVILLE, IN (1)	02
AGP016702	MARTIN MARIETTA @ PETERSBURG	06
AGP016902	SCOTTY'S CONTRACTING @ ELKTON (1)	03
AGP017702	MARTIN MARIETTA @ ELIZABETHTOWN, OHIO	06
AGP019202	OHIO VALLEY SAND & GRAVEL @ PADUCAH (3)	01
AGP019602	JAY MAR INC @ MARIETTA, OHIO (2)	09
AGP019702	HANSON AGGREGATES @ CLEVELS, OHIO	06
AGP019902	WELCH SAND & GRAVEL N. @ ROSS, OHIO (2)	06
AGP020102	RIVER SAND AND GRAVEL @ VANCEBURG (3)	09
AGP020402	JOHNSON CONSTRUCTION MATERIALS @ BETHLEHEM, IN	05
AGP020502	HARRISON SAND & GRAVEL @ WEST HARRISON, INDIANA	06
AGP020802	LETART CORP SAND & GRAVEL @ HUNTINGTON, WV (2)	09
AGP021102	WATSON GRAVEL @ HARRISON, OHIO (AGG)	06
AGP021202	NUGENT SAND @ WARSAW	06
AGP021402	BIG SANDY RESOURCES @ LOUISA	12
AGP021502	TOW PATH READY MIX @ LUCASVILLE, OHIO (AGG) (2)	09
AGP021602	GRIFFIN SAND @ GRIFFIN, INDIANA (2)	02
AGP023102	SHELLY MTRLS INC. WILLOW ISLAND @ MARIETTA, OH (2)	09
AGP023202	WATSON GRAVEL @ CLEVELS, OHIO	06
AGP025002	SHELLY MTRLS INC. PORTLAND @ PORTLAND, OH (1)	09
AGP025102	TUG RIVER SAND @ LOUISA (1)	12
AGP025602	TRI-COUNTY SAND AND AGGREGATE (1) @ BUFFALO, KY	04
AGP025902	BONNIEVILLE STONE, LLC. (2) (AGG) @ BONNIEVILLE, KY	04

Source: (Kentucky Transportation Cabinet, 2010b)

Figure 8.6: Asphalt plant locations in Mississippi



Source: www.superpave.com

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